

REPORT BY THE

Comptroller General

OF THE UNITED STATES

Stronger Direction Needed For The National Earthquake Program

The Federal Emergency Management Agency (FEMA), the lead agency for the National Earthquake Program, needs to do more to fulfill the requirements of the Earthquake Hazards Reduction Act of 1977. FEMA's newly formed Earthquake Policy Review Group can provide needed direction to the Federal agencies in the program by improving interagency planning, budgeting, and evaluation.

Progress has been slow in developing earthquake response plans at the State and local levels and in the private sector. Future progress will depend on adequate FEMA direction and on the resources available to those preparing the actual plans.

An operational earthquake prediction system--an objective of the 1977 act--has not been developed because necessary technological advances have not occurred. Current monitoring systems can produce warnings that geological conditions suggest an impending earthquake, but not routine predictions. Further basic research is needed before reliable short-term predictions are feasible.



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COMPTROLLER GENERAL OF THE UNITED STATES
WASHINGTON D.C. 20548

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The Honorable Slade Gorton
Chairman, Subcommittee on Science,
Technology and Space
Committee on Commerce, Science and
Transportation
United States Senate

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Dear Mr. Chairman:

This report evaluates efforts by the Federal Emergency Management Agency to carry out the lead agency role assigned to it by the National Earthquake Hazards Reduction Act of 1977. The report also describes Federal activities to assist State and local governments with earthquake response planning and discusses reasons why a prediction system has not been developed. Our review was conducted in response to your request of June 1, 1982.

As arranged with your office, we are sending copies of this report to the Director, Office of Management and Budget; the Director, Federal Emergency Management Agency, and the heads of the other primary Federal organizations conducting earthquake-related activities; interested congressional committees, subcommittees, and individual Members of Congress; and other interested parties. Copies will be available to others on request.

Sincerely yours,

Comptroller General
of the United States

U. S. DEPARTMENT OF COMMERCE NOAA
COASTAL SERVICES CENTER
2234 SOUTH HOESON AVENUE
CHARLESTON, SC 29405-2413

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D I G E S T

The Earthquake Hazards Reduction Act of 1977 was enacted to establish a National Earthquake Hazards Reduction Program to reduce the risks to life and property from future earthquakes in the United States. The act assigns the President and the Federal Emergency Management Agency (FEMA) certain duties to pull together the efforts of Federal agencies and other affected groups into a coherent program. (See pp. 1 to 3.)

The President delegated functions vested in him by the act to FEMA in 1979 when he designated FEMA as the lead agency. FEMA has taken some positive steps to improve interagency coordination since then. However, GAO found that FEMA has not carried out several responsibilities assigned to it under the act and its 1980 amendments and has fallen behind schedule on others. (See p. 7 to 11.)

GAO believes that FEMA could better prepare the United States for a major earthquake by more aggressively implementing the act's requirements and providing stronger guidance and direction to Federal agencies.

In response to a request from the Subcommittee on Science, Technology and Space, Senate Committee on Commerce, Science and Transportation, GAO reviewed (1) FEMA's efforts to carry out its lead agency responsibilities, (2) assistance provided to State and local governments in reducing earthquake risks, and (3) progress toward developing a prediction system.

FEMA DEFINES ITS ROLE AS COORDINATOR
RATHER THAN MANAGER

FEMA has been gradually taking on an expanded role as lead agency. Between 1979 and mid-1981 FEMA made limited attempts to function as the lead agency. The limitations on this activity can be attributed, in part, to startup problems associated with FEMA's formation. (See p. 11.)

Since mid-1981, FEMA has taken several actions to coordinate agency activities. It formed an Interagency Coordination Committee of mid-level officials from Federal agencies conducting earthquake-related activities, submitted to the Congress annual reports for 1981 and 1982, and prepared a draft 5-year plan which it expects to finalize in 1983. More recently, in January 1983, it formed an interagency Policy Review Group of policy-level officials which FEMA looks to as the mechanism that will bring separate agency actions together into a coherent program. (See pp. 8 to 13.)

However, FEMA has generally left to each agency those management decisions associated with planning, budgeting, and evaluating its respective earthquake activities. This was done because FEMA has narrowly defined its role as lead agency, functioning more as a "coordinator," in the sense of bringing people together to exchange information, rather than as a leader or manager. FEMA program officials view their lead role as one which is evolving over time and now believe it is time to provide stronger leadership. (See pp. 7 and 15.)

Largely because FEMA has confined its lead role to coordinating agency activities, it has not carried out a number of management-type responsibilities specifically assigned to it by the President and the act. These include:

- Assigning and specifying the role and responsibilities of each Federal agency.
- Establishing goals, priorities, budgets, and target dates.
- Completing a program plan by September 30, 1981.
- Evaluating, in timely annual reports, the progress achieved. (See pp. 7 to 11.)

Establishing goals, priorities, budgets, and target dates for the overall program is especially important because they are not detailed in the act. The act requires that the program be designed and administered to achieve several objectives, including implementing a prediction system, developing earthquake-resistant design and construction methods, and improved understanding of and planning for earthquakes. However, the act does not set priorities for these objectives or designate timeframes for their achievement. (See p. 8.)

FEMA can improve compliance with the act's requirements by developing its newly formed interagency Policy Review Group into a deliberative body within which agencies come together to decide on goals, priorities, and budgets and address program issues, including the relative priority of developing an operational prediction system. When this is accomplished, FEMA should determine whether financing the operations of the Policy Review Group requires specific statutory approval. (See pp. 11, 22, and 43.)

GAO recommends that the FEMA Director formalize and strengthen the role of the interagency Earthquake Policy Review Group as the program's oversight and management body by scheduling regular meetings and by instituting a process that will bring important issues before it for decision, including establishing program goals, priorities, budgets, and target dates, and request, if necessary, specific congressional funding for its activities. (See p. 22.)

FEDERAL, STATE, AND LOCAL PLANNING EFFORTS: SLOW PROGRESS

FEMA is responsible for guiding Federal, State, and local government planning to respond to and minimize the damage, deaths, and injuries resulting from severe earthquakes through rescue efforts, building codes, and other measures. Planning has progressed more slowly than anticipated by Federal planners in 1979. Much remains to be done. For example, most of the 10 locales designated for earthquake response planning in 1979 still need to update or prepare their plans. FEMA later designated two more high-risk locales. (See pp. 25 to 33.)

Review of response planning efforts to date suggests that development of adequate plans depends not only upon FEMA's continued efforts, but also upon the availability of resources of other Federal agencies to prepare their plans, and upon the cooperative efforts of State and local governments. FEMA intends for 11 of the 12 locales to complete their planning by 1988. (See pp. 26 and 32.)

NEED TO DETERMINE PREDICTION SYSTEM'S PRIORITY

One objective of the 1977 act provided for implementing a system for predicting damaging earthquakes in all areas subject to high or

moderate seismic risk. The technological advances which would have made such a system feasible have not occurred, so program participants have not developed an operational prediction system. The U.S. Geological Survey is studying the requirements for one as a preliminary step. (See pp. 36 and 41.)

The benefits of a prediction system could be substantial and some officials believe it is appropriate to place greater emphasis on developing an operational prediction system. But Geological Survey officials and others question whether it is currently feasible to begin developing a system for making short-term predictions without further basic research. Monitoring systems currently in place in California primarily for research purposes could produce warnings that geological conditions suggest an impending earthquake, but not predictions as routine as weather forecasts. (See pp. 36 to 38.)

GAO is recommending that FEMA determine, through the interagency body, the level of priority that should be assigned to achieving advances in technology and knowledge necessary to make a prediction system feasible. This determination should weigh the costs and uncertainties of a prediction system against the potential benefits of reducing loss of life and injuries as well as reducing property damage and disruption. (See p. 43.)

AGENCY COMMENTS

GAO received comments on a draft of this report from the four principal Federal agencies in the program--the Department of the Interior, for the Geological Survey; the National Science Foundation; the National Bureau of Standards; and FEMA. Generally, they said that FEMA should remain as lead agency and that FEMA can most effectively carry out its leadership role in a "collegial," or cooperative, manner with other program participants.

In a draft of this report, GAO had proposed that the FEMA Director put in place an interagency body to develop and implement a National Earthquake Hazards Reduction Program as required by law. FEMA's response was that its recently formed Earthquake Policy Review Group was the best forum to carry out the act's requirements, including determining program priorities. GAO believes that

this Group, which is now in its formative stage, could develop into an effective interagency body and is now recommending specific functions for the Group to perform as it develops into a viable entity. (See pp. 10 and 22.)

GAO had also proposed in its draft report that a temporary Office of Science and Technology Policy task force be established to assist FEMA in developing a management system of planning, budgeting, and evaluation. Interior and FEMA disagreed with the need to form such a task force and said that existing coordinating groups could assist FEMA in carrying out its lead agency responsibilities. Because FEMA appears on its way to establishing a joint decisionmaking process to deal with overall management and budget issues of the program, GAO has dropped its proposal for a separate task force. GAO's main concern is that the program be effectively managed in accordance with the act.

Interior stated that development of an operational prediction system is premature and listed seven related issues needing additional study before large expenditures are made to implement a prototype system. The issues include the funding level needed, funding sources, and economic costs and benefits. GAO agrees with the need to address these issues before going forward with development. (See p. 43.)

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ABBREVIATIONS

FEMA	Federal Emergency Management Agency
GAO	General Accounting Office
NBS	National Bureau of Standards
NEHRP	National Earthquake Hazards Reduction Program
NOAA	National Oceanic and Atmospheric Administration
NSF	National Science Foundation
OMB	Office of Management and Budget
OSTP	Office of Science and Technology Policy
R&D	research and development
USGS	U.S. Geological Survey

CHAPTER 1

INTRODUCTION

The Earthquake Hazards Reduction Act of 1977 established the National Earthquake Hazards Reduction Program to mitigate the impact of earthquakes on communities. The Chairman, Subcommittee on Science, Technology and Space, Senate Committee on Commerce, Science and Transportation, requested that we review the appropriateness of the program's organizational structure for meeting the purposes of the act. As agreed with the subcommittee's office, we focused our work on (1) the Federal Emergency Management Agency's (FEMA's) efforts to carry out its lead agency responsibilities for the program, (2) assistance provided to State and local governments in mitigating earthquake hazards, and (3) progress toward developing an operational earthquake prediction system.

EFFECTS OF A POSSIBLE CATASTROPHIC EARTHQUAKE

Earthquakes pose perhaps the greatest single-event, natural hazard faced by the Nation. An earthquake can affect hundreds of thousands of square miles and cause catastrophic damage to property and unprecedented loss of life and injury. It can also disrupt the social and economic functioning of the affected area. Because few major earthquakes have occurred in the United States since 1900, they have caused less aggregate damage than have hurricanes, tornadoes, or floods. However, the potential for disaster in the United States has multiplied in recent years because of the rapid development that has taken place in the most seismically¹ prone areas throughout the country.

The U.S. Geological Survey (USGS) has reported that the probability of a catastrophic earthquake occurring in the next 30 years near Los Angeles is greater than 50 percent. In 1980, FEMA published estimates that such an earthquake, depending on where it was centered, could cause \$15 billion to \$70 billion in damages and kill 3,000 to 23,000, depending on people's activities when it occurred. Additional thousands would be injured.

THE EARTHQUAKE HAZARDS REDUCTION ACT

Section 5 of the Earthquake Hazards Reduction Act of 1977 (42 U.S.C. 7701 et seq.) directs the President to establish and

¹Seismic, seismically: of, subject to, or caused by an earthquake.

maintain a coordinated earthquake hazards reduction program, designed and administered to achieve the objectives and carry out the research and mitigation elements² set forth in the act. The act's objectives include

- developing more earthquake-resistant buildings through better codes, design, and construction methods and procedures;
- implementing a prediction system;
- educating the public and State and local officials to encourage mitigating action; and
- developing research that will further the basic objective of mitigating earthquake impacts.

Specific lines of effort in research include inquiring into the basic causes and mechanisms of earthquakes, developing prediction methods, and developing information, methods, techniques, and guidelines leading to safer buildings and land use. (See app. I.)

Executive Order 12148, dated July 20, 1979, designated FEMA as the lead agency for the earthquake program and delegated all functions vested in the President by the act to FEMA's Director. The act was amended on October 19, 1980, to add a provision assigning to FEMA the primary responsibility to plan and coordinate the earthquake program. Executive Order 12381, dated September 8, 1982, delegated all functions vested in the President under the amended act to FEMA.

As amended, the act and executive orders require FEMA to

- design and administer the program to achieve the act's objectives;
- assign the role and responsibilities of each appropriate Federal department, agency, and entity;
- establish goals, priorities, budgets, and target dates for implementing the national earthquake program;
- provide for qualified and sufficient staffing;

²Mitigation of the effects of an earthquake includes such measures as building codes, land-use planning, and public education.

- compile and maintain a written 5-year program plan with base and incremental budget options;
- provide a method for cooperation and coordination with interested governmental entities in all States;
- prepare an annual report describing and evaluating progress achieved; and
- coordinate the activities of program participants.

The act's requirements are listed in appendix II.

PROGRAM ACTIVITIES AND FUNDING

FEMA, USGS, the National Science Foundation (NSF), and the National Bureau of Standards (NBS) are the four principal Federal agencies with responsibilities in the national earthquake program. In addition to its lead agency responsibilities, FEMA is responsible for coordinating Federal, State, and local disaster response planning under its other authorities. Most of its staffing and attention and its \$1.1 million program funding for 1982 were directed to the latter activities. USGS used its \$32.6 million 1982 program funds to conduct assessments of geological hazards and to conduct and sponsor research on the nature of earthquakes, earthquake prediction, and induced seismic activity which is sometimes produced when new reservoirs are filled. NSF used its \$25.3 million in 1982 to sponsor fundamental studies on earthquake processes and basic and applied research on earthquake engineering and socioeconomic implications of earthquakes. NBS used its \$0.5 million in 1982 for research on performance criteria and supporting measurement technology for earthquake-resistant construction. In addition, NBS provided technical assistance for the development of earthquake-resistant design and construction provisions.

Appropriations to the primary Federal agencies for the program have remained relatively constant since 1978. The 1982 appropriations for all agencies were about \$59 million, an increase of about \$8 million over 1978 funding. Since 1978, program funding to USGS and NSF has accounted for about 96 percent of the total appropriations; FEMA received only about 3 percent. A more detailed funding history for the various agencies is shown in the table below.

Table 1

National Earthquake Hazards Reduction Program Funding

	<u>1978</u>	<u>1979</u>	<u>Actual</u> <u>1980</u>	<u>1981</u>	<u>1982</u>	<u>Estimated</u> <u>1983</u>
	------(millions)-----					
USGS	\$28.2	\$31.4	\$32.0	\$32.3	\$32.6	\$34.5
NSF	23.0	22.9	24.8	25.1	25.3	24.8
NBS	0.2	0.4	0.4	0.4	0.5	0.5
FEMA	<u>-</u>	<u>-</u>	<u>1.2</u>	<u>1.5</u>	<u>1.1</u>	<u>3.1</u>
Total	<u>\$51.4</u>	<u>\$54.7</u>	<u>\$58.4</u>	<u>\$59.3</u>	<u>\$59.5</u>	<u>\$62.9</u>

OBJECTIVES, SCOPE, AND METHODOLOGY

Our objective was to review the current organizational structure and the assignment of responsibilities to various Federal agencies under the National Earthquake Hazards Reduction Program. As agreed with the office of the Subcommittee on Science, Technology and Space, Senate Committee on Commerce, Science and Transportation, we focused our work on FEMA's efforts to carry out its lead agency responsibilities for the program. We also reviewed Federal, State, and local efforts to respond to and minimize the deaths and damage caused by earthquakes. Because the subcommittee was primarily concerned with FEMA's role in planning and coordinating the program, we did not evaluate the effectiveness of the research and mitigation activities of each agency in the program.

We reviewed the requirements of the Earthquake Hazards Reduction Act of 1977, as amended, and assessed reports, planning documents, and data pertaining to the planning, organization, and management of earthquake activities at the Washington headquarters of the Federal agencies primarily responsible for the earthquake program--FEMA, USGS, NSF, and NBS. We discussed the earthquake program with responsible officials in these agencies, the Office of Management and Budget (OMB), and the Office of Science and Technology Policy, as well as officials in other agencies who are members of the Interagency Committee on Seismic Safety in Construction. These included the Veterans Administration, Department of Defense, Army Corps of Engineers, Department of Housing and Urban Development, Environmental Protection

Agency, and the Federal Highway Administration. The Interagency Committee's purpose is to develop guidelines to assist Federal agencies in implementing earthquake hazards reduction measures in their construction programs.

To obtain a better understanding of the extent of coordination between agencies involved in the earthquake program, we reviewed interagency efforts initiated by FEMA and the coordination between the Emergency Mobilization Preparedness Board's Earthquake Working Group and FEMA; we also observed an NSF Earthquake Hazards Mitigation Advisory Subcommittee meeting and a USGS/FEMA meeting. The purpose of the latter meeting was to develop a memorandum of understanding on responding to geologic conditions that threaten public safety and property, including earthquakes. We also analyzed the organization and structure of three multiagency programs to determine whether elements of their management structure could be applied to the earthquake program. These programs were the Acid Precipitation Program, the National Ocean Pollution Research Program, and the National Climate Program.

We interviewed FEMA officials at headquarters and region IX and California State officials with respect to FEMA's response and mitigation planning activities and analyzed pertinent reports, studies, and planning documents to determine progress and problems and the potential effectiveness of those activities. We reviewed contracts and reports on the activities and progress of the Southern California Earthquake Preparedness Project in the Los Angeles area--a FEMA-State-local earthquake response and mitigation planning effort. We also considered data and reports on State and local government activities obtained at State offices in Sacramento, California, in evaluating FEMA's response and mitigation planning activities.

To evaluate the advisability of developing a prediction system, we reviewed USGS technical reports and budget data and correspondence from university researchers on the relative priorities that should be placed on earthquake prediction research and development of an earthquake prediction system. We interviewed officials from USGS national headquarters in Reston, Virginia, and Western Region Headquarters in Menlo Park, California, to determine how an operational prediction system would differ from the existing research-oriented seismic monitoring systems.

Our review was performed in accordance with generally accepted government auditing standards.

CHAPTER 2

FEMA SHOULD MORE AGGRESSIVELY

CARRY OUT ITS LEAD AGENCY RESPONSIBILITIES

The Federal Emergency Management Agency--the program's lead agency--has not carried out or fulfilled in a timely manner a number of lead agency responsibilities assigned to it by the Earthquake Hazards Reduction Act of 1977, as amended, and delegated to it by the President. For example, FEMA has not fulfilled certain planning and staffing responsibilities that are specifically required by the act, including transmitting to the Congress a multiyear program plan for earthquake hazards reduction. In addition, FEMA has not carried out its role concerning (1) the assignment of agency roles and responsibilities that are to be consistent with specific objectives of the act and (2) the establishment of goals, priorities, budgets, and target dates for implementing the program.

FEMA program officials view their lead agency role as an evolutionary one. FEMA did not begin operations until April 1979 and was not assigned lead agency responsibility until July 1979. For about the next 2 years, FEMA's efforts were limited as it faced funding problems and concentrated on resolving startup problems associated with its formation. Starting about mid-1981, FEMA began taking some actions to coordinate program activities; these actions were designed to promote the exchange of information but not to establish a management structure for the program. Until late 1982, FEMA had narrowly defined its role as lead agency, preferring to function primarily as a coordinator. In 1983, FEMA's program officials have begun to assume a more aggressive leadership role and have formed an interagency Earthquake Policy Review Group to bring high-level officials together to address program policy issues.

By more aggressively implementing the act's requirements and providing stronger guidance and direction to program participants, FEMA could more effectively prepare the United States for the next major earthquake. These requirements could be effectively carried out through an interagency body within which agencies could come together to address program issues and agree to adjust their priorities and budgets. Such a body would also help direct proper funding and management attention to more important projects.

FEMA NEEDS TO PROVIDE
STRONGER GUIDANCE
AND DIRECTION

The Earthquake Hazards Reduction Act of 1977, as amended, intended to pull together the fragmented efforts of various Federal agencies into a unified national program by assigning to the President and FEMA these management-type functions:

1. Assigning roles and responsibilities for each participating agency.
2. Establishing goals, priorities, budgets, and target dates.
3. Providing for qualified and sufficient staffing.
4. Maintaining a written multiyear program plan.
5. Providing for participation of governmental entities, the private sector, the public, and the professions.
6. Reviewing and evaluating program activities.
7. Coordinating program activities.

In addition, the act provides that the program be administered to achieve the objectives and include the research and mitigation elements set forth in the act. More detail on program functions required by the act is provided in appendix II.

Important management functions
not being carried out

FEMA has not carried out certain planning, budgeting, and evaluation functions for the earthquake program required by the act and the executive orders. These functions are being carried out independently by the individual agencies rather than centrally from an overall program standpoint. Mandated functions not being carried out include the following:

- Assigning and specifying the role and responsibility of each Federal agency.
- Establishing program goals, priorities, and target dates and developing and updating a program plan.
- Developing a process to prepare a program budget.

--Evaluating progress achieved in the program's annual report.

--Designing and administering the program to achieve the act's objectives and the act's research and mitigation elements.

Overall program goals, priorities, and established target dates are not being set in a unified way. FEMA has also not assigned and specified roles and responsibilities to participating Federal agencies. No process existed to bring together the various agencies to address important issues jointly. Establishing goals, priorities, budgets, and target dates for the overall program is especially important because these are not detailed in the act. The act requires that the program be designed and administered to achieve several objectives, including implementation of a prediction system, development of earthquake-resistant design and construction methods, and improved understanding of and planning for earthquakes. However, the act does not prioritize these objectives or designate timeframes for their achievement.

Until FEMA takes steps to provide such necessary program guidance and direction, participants will have no sound basis upon which to allocate their resources and no sound foundation on which to develop a national program. FEMA's Acting Deputy Director and Assistant Associate Director for Natural and Technological Hazards agreed that the program needed improved management and more aggressive leadership. They explained that FEMA's role has been evolving, but not as quickly as they had planned.

FEMA began taking steps in April 1982 toward preparing a 5-year program plan. FEMA has placed emphasis on completing this plan to provide coherence and direction to the overall program and has involved other agencies in its preparation. The act, as amended, directed FEMA to complete and submit this plan to the Congress by September 30, 1981. As of March 1983, submission of the plan to the Congress was several months away. FEMA's delay in completing the plan was one reason why the subcommittee, in Senate Report 97-336, stated that it would ask us to examine the program. We reviewed a September 1982 version of the draft program plan and found that it was essentially a collection of individual agency plans. It did not include an integrated timetable; nor did it present goals and priorities that showed how the plan would achieve the act's objectives.

In September 1982, an independent panel of experts established by FEMA began evaluating the draft program plan. The panel's work was still underway in March 1983. The panel found the general thrust of the draft plan to be appropriate, but major sections were unacceptable as to content, emphasis, or style. The panel has been working on revising the draft based on its assessment.

FEMA has not developed a consolidated budget or proposed a joint process to set the required budget for the earthquake program as the act requires. Each agency has developed a budget for its own earthquake activities. The agencies have then requested and received appropriations from their own congressional appropriation subcommittees. No overall review of agency requests has taken place as part of an integrated program budget. A budget process is needed, we believe, which would establish the total funding level for the entire program with the assistance of OMB, and then the affected agencies could meet to consider and agree upon an allocation of those funds, consistent with program priorities, to the various program objectives and elements. Such a process would assist program managers in reallocating funds from less important projects, and identifying new initiatives. It would also enable the lead agency to monitor the efforts of other participating agencies and help ensure an efficient and effective program. A consolidated budget process similar to that described here is used in the Acid Precipitation program administered by an interagency task force.

The act directs the President to submit an annual report to the Congress within 90 days after the end of each fiscal year. The report is to describe and evaluate progress achieved in reducing the risks of earthquake hazards during the preceding fiscal year. FEMA has submitted two annual reports (fiscal years 1981 and 1982) to the Congress since the President delegated this task to FEMA in 1979. The program's only other annual report was prepared for fiscal year 1979 by the Office of Science and Technology Policy, an independent agency which coordinated initial interagency efforts under the 1977 act. The annual report for fiscal year 1982, due to the Congress at the end of December 1982, was not submitted until mid-March 1983. These annual reports describe agencies' efforts but do not evaluate them. An annual evaluation of the program's progress as called for in the act has never been conducted. The independent panel established by FEMA to evaluate the draft program plan is the closest FEMA has come to an evaluation of the overall program. While we believe that the panel's work is a step in the right direction, we also believe that it cannot adequately evaluate the overall program unless agreed-upon and

approved program goals, priorities, and target dates are in place.

The act explicitly sets forth seven program objectives, nine research elements, and eight mitigation elements. The act directs that the President establish a program that is designed and administered to achieve the act's objectives and includes the research and mitigation elements. (The President has delegated this responsibility to FEMA.) Our review of four program documents--the 1978 implementation plan, the 1979 and 1981 annual reports, and the September 1982 draft program plan--found that none both specifically listed these objectives and elements and showed for each objective and element how agency responsibilities, activities, and resources will achieve progress toward accomplishing them within prescribed target dates.

In January 1983, FEMA's Associate Director established an interagency Earthquake Policy Review Group of policy-level officials from the four principal Federal agencies. According to the Associate Director, the purpose of this Group is to deal with overall program policy issues. In its comments on our draft report, FEMA said that this Group would oversee the necessary program planning, budgeting, and evaluation required by the act.

We believe it is too early to say whether this Policy Review Group will develop into an interagency body that will provide the necessary guidance and direction to the Federal agencies participating in the program. By "interagency body" we mean a deliberative body of policy-level representatives of the principal Federal agencies in the program which makes decisions affecting the goals, priorities, budgets, and target dates for the earthquake-related activities of each of these agencies. The precise form of such a body should be developed by FEMA in cooperation with the other agencies. Although having met several times in early 1983, as of May 1983 the Group was still operating on an informal basis--minutes were not kept and a charter setting out its functions and objectives had not been approved. An effective interagency body will require agreement by the principal agencies as to its purpose and mode of operation. The agencies' official comments on this report indicate that there is not yet agreement on the role of the Policy Review Group. Whereas NSF cited the Policy Review Group as the body "to coordinate the earthquake hazards reduction program," the Department of the Interior did not mention it at all. Instead, Interior referred to the Interagency Coordination Committee, another interagency group consisting of mid-level officials, as the mechanism "to coordinate activities among the several federal agencies that participate" in the program. NBS did not

refer to either the Policy Review Group or the Interagency Coordination Committee.

When the mode and structure of the Earthquake Policy Review Group is more definitely established, we suggest that FEMA determine whether financing the Group's future operations requires specific statutory approval. Under certain circumstances the use of any appropriations for interagency financing of boards, commissions, or similar bodies is restricted without such approval.¹ If FEMA determines that the nature of the Policy Review Group's activities and expenditures makes it subject to such restrictions, FEMA should seek specific statutory authority to finance its operations.

FEMA HINDERED BY ORGANIZATIONAL PROBLEMS AND UNCERTAINTY ABOUT ITS AUTHORITY

We found that FEMA has not exercised aggressive leadership in the Earthquake Hazards Reduction Program due to (1) startup problems associated with its formation, (2) limited technical expertise and staffing, and (3) uncertainty about its authority and lead role.

Startup problems of a new agency

FEMA was not designated as lead agency until July 1979 when the President issued Executive Order 12148 delegating his responsibilities under the act to FEMA. The President had created FEMA only months prior to the Executive order as a part of an executive branch reorganization. Two years passed before FEMA began taking steps to coordinate program activities. Program officials at USGS, NSF, and NBS confirmed that FEMA was relatively inactive in its role as lead agency and that its efforts did not improve until about mid-1981. FEMA officials also noted that FEMA received no earthquake program funding in 1979 (see table 1, p. 4), a fact linked to the agency's early inactivity.

We found that FEMA's lack of involvement in the program during the first 2 years of its existence (1979-81) can be

¹See, e.g., § 101(a) of Public Law No. 97-377, 96 Stat. 1830 (1982); § 609 of H.R. 7158, 97th Cong.; § 608 of Public Law No. 96-74, 93 Stat. 559 (1979).

attributed, in part, to reorganization startup problems--such as delays in bringing key officials on board, inadequate office space, and insufficient staffing. By 1982, internal management systems still had not been established to integrate top management, the various program offices, and regional office operations. The FEMA Director has been concerned about the need to develop such systems. Our recent report, "Management of the Federal Emergency Management Agency--A System Being Developed" (GAO/GGD-83-9, Jan. 6, 1983), discussed these matters and addressed progress made by the agency in improving its management.

Limited technical expertise and staffing

FEMA has not provided sufficient staffing and dedicated a high-level official to manage its lead agency responsibilities. FEMA's current staffing is adequate for the limited task of coordinating the exchange of information among program participants. However, FEMA has many mandated lead agency duties such as maintaining a program plan, evaluating progress, and establishing priorities and budgets. In order to provide effective leadership for this complex, technical program, which involves the private sector, various governmental levels, and several Federal agencies, FEMA needs a dedicated staff with appropriate technical expertise.

FEMA could supplement its resources by making more use of experts temporarily detailed from other agencies or by forming a standing advisory panel. In its comments on our draft report, FEMA said it plans to form an advisory board to conduct frequent assessments and evaluations of the program. The costs for this proposed advisory board and/or a dedicated staff to effectively perform overall program functions should be considered a legitimate cost to meet the Congress' intent for a national earthquake program.

FEMA has some expertise in coordinating emergency planning and response efforts; however, it does not have the technical expertise needed to deal effectively with questions involving earthquake research funded or conducted by USGS, NBS, or NSF. The need for technical expertise was cited by people with whom we talked as a factor inhibiting development of FEMA's leadership role. FEMA occasionally uses outside experts to fill the void in technical areas. For example, it recently signed a \$600,000 contract with the Building Seismic Safety Council to test the adequacy of tentative design provisions for earthquake-resistant construction. In addition, FEMA established an independent panel of experts to review the draft program plan.

Most Federal and State officials with whom we talked told us that it was their perception that the program was not a FEMA priority. FEMA officials maintained that it was. We noted that FEMA has assigned limited resources to program management. FEMA has assigned about eight professional staff to the program. However, only one of these individuals carries out lead agency functions for the program--the special assistant to the Chief of the Natural Hazards Division. We found that this special assistant, who reports to an official who is three organizational levels below the FEMA Director, is the only FEMA professional who devotes a substantial amount of time to FEMA's lead agency responsibilities. The other professionals carry out FEMA's mission responsibilities related to the program that FEMA would perform even if it were not the lead agency.

FEMA has three management-level officials assigned to handle its lead agency responsibilities: the Chief, Natural Hazards Division; the Assistant Associate Director, Office of Natural and Technological Hazards; and the Associate Director, State and Local Programs and Support Directorate. None of these is recognized by program participants as the program manager. While the Associate Director for the State and Local Programs and Support Directorate is organizationally FEMA's top official responsible for FEMA's duties under the program, he has other important responsibilities requiring his attention. The Associate Director also is responsible for other natural disasters, technological hazards, civil defense, disaster assistance, response planning and coordination, and emergency management. He does not chair the Interagency Coordination Committee, the program's primary coordinating body, established in late 1981 (see app. IV.).

The Assistant Associate Director serves as Chairperson of the Interagency Coordination Committee, but he told us that he has not been involved in the program as much as he would like. The Chief of the Natural Hazards Division is the primary day-to-day FEMA manager handling FEMA's lead agency responsibilities and coordinating program activities with other agencies. He also has responsibilities in other program areas, including the National Flood Insurance Program, which require his time and attention. He estimates that he spends about 20 percent of his time on earthquake program activities.

We found that extensive coordination to exchange information was occurring among the concerned agency officials and others interested and involved in earthquake-related activities. The coordination is both formal and informal. The formal coordination takes place through associations; standing committees and panels; and seminars, workshops, and conferences. (Selected formal coordination arrangements are listed

and described in apps. IV and V.) Conferences and workshops sponsored by USGS, NSF, NBS, and FEMA bring together representatives of various professions and Federal, State, and local governments. The conferences and workshops are usually organized around specific topics, such as ways to estimate earthquake losses or techniques for mapping earthquake effects.

Informal coordination occurs in the day-to-day working environment as managers and professionals develop personal contacts and keep abreast of developments in their area. Agency officials stressed to us that the "earthquake community" is a small one and that an informal network allows for the smooth flow of information.

These informal bodies can keep program participants informed but have not been effective for performing functions involving leadership and management. We believe that a dedicated program manager and sufficient staffing are needed to produce compliance with the act's requirements.

We noted that the three other multiagency programs included in our review (see ch. 1) all had a program office in addition to an interagency committee to oversee and manage the program. The programs varied as to the authority and functions assigned the office compared to the committee. FEMA does not have an office dedicated to national earthquake program management. All earthquake-related activities in FEMA are located in the Office of State and Local Programs and Support, with lead agency responsibilities assigned to the Natural Hazards Division. This Office is responsible for all hazards, including earthquakes, and all phases of emergency management. There are no separate organizational units dedicated to specific types of hazards, such as hurricanes or earthquakes. According to FEMA, this organizational arrangement allows for a multihazard approach, which allows FEMA to better prepare for all emergencies, regardless of the type. FEMA also maintains that this alignment strengthens earthquake activities at the State and local levels because of the capability to share resources allocated to other disaster programs, including civil defense, disaster assistance, emergency preparedness, and flood plain management.

FEMA's organizational philosophy appears to be a sensible approach for carrying out its mission responsibilities. However, we question whether it is adequate for leading a specific national program as required by the 1977 earthquake act. FEMA's Acting Deputy Director told us that, although he would have opposed the idea a year ago, he agreed with us that establishing an earthquake program office has merit because it would establish a central location identified by program participants as being the principal source of information on the program.

Uncertainty about role and authority

FEMA's Acting Deputy Director and Assistant Associate Director initially questioned whether they have sufficient authority to become involved in other agencies' budget and management decisions. As a result of this interpretation, FEMA's approach for meeting the act's requirements for program plans, goals, priorities, target dates, and budgets has been to have individual agencies establish these for their own assigned responsibilities. FEMA has narrowly defined its role as lead agency and has functioned more as a "coordinator," in the sense of bringing agencies together to exchange information rather than as a leader or manager. However, at a recent meeting top FEMA officials advised us that FEMA's official position is that it currently possesses adequate legislative authority to carry out its lead agency functions under the act.

FEMA's Acting Deputy Director and Assistant Associate Director for Natural and Technological Hazards told us that they have viewed FEMA's lead agency role as one which is evolving over time. They now believe that FEMA should play a more aggressive leadership role and agreed with us that a joint decisionmaking process to bring together the planning and budgeting of the various agencies would help improve the program.

PROGRAM ISSUES NOT ADEQUATELY ADDRESSED

The absence of a program plan setting out goals, priorities, and target dates; a consolidated program budget; periodic program evaluations; and assigned agency responsibilities tied directly to the act's objectives raises questions as to whether individual agency efforts are carried out efficiently and are effective in achieving program goals and priorities.

Our review identified the following three issues, which we do not believe are being adequately addressed from an overall program standpoint because of the absence of program goals, priorities, and budgets. Furthermore, these are the types of issues that a comprehensive program evaluation should deal with but has not.

- How can the Federal Government best impress upon others the need to implement measures to mitigate earthquake hazards? Should it set the example for the rest of the country by establishing its own earthquake-resistant construction standards, given its lack of success and the lack of agency interest? If so, should this be a high priority?

- Is the program coherent and properly balanced both within and between program elements? That is, are the types of projects being undertaken in line with program goals and priorities? Do the projects complement and build on each other? Are maximum benefits being obtained from limited program resources? Are enough research findings being applied?
- What priority should be given to developing an operational prediction system in this decade, given its high cost and the uncertain probability of success?

The first two questions are addressed below. Question 3 is discussed in chapter 4.

Should the Federal Government develop its own construction standards?

In transmitting an initial Program Implementation Plan to the Congress in 1978, the President emphasized that "the Federal Government must set a strong example in developing guidelines and standards for its own facilities." The plan specifically established, as an immediate program priority, the development of earthquake-resistant design and construction standards for Federal construction. The Interagency Committee on Seismic Safety in Construction was formed for this purpose, and FEMA was assigned to provide leadership to the Interagency Committee. The Interagency Committee is composed of 17 Federal departments and agencies engaged in construction, the financing of construction, or related activities.

We believe an evaluation of the Interagency Committee's purpose and objectives is needed because 4-1/2 years have passed since the issuance of the implementation plan. Our review identified the following factors during this period which question the value of the Interagency Committee:

- Although the Interagency Committee was intended to set the example for the non-Federal sector by establishing Federal earthquake-resistant construction standards, the Interagency Committee has been inactive for the last year and the draft standards which it prepared in January 1981 have yet to be tested. Recently, FEMA and NBS have initiated efforts to revitalize the Interagency Committee.
- Federal agencies, including the Veterans Administration and the Federal Highway Administration, have separately developed earthquake-resistant construction standards critical to their mission-related facilities.

--There is a related effort funded by FEMA being carried out by the Building Seismic Safety Council to develop guidelines for the private sector. The two separate efforts are intended to merge sometime in the future.

In its response to our draft report, NBS stated that the Interagency Committee's effort has contributed to the development of uniform standards for earthquake-resistant buildings which are consistent with the private sector national standards to be used for State and local governments' building codes. (See app. VIII.) NBS also presented several factors suggesting the continued need for the Interagency Committee.

We recognize that the Interagency Committee has contributed to the development of uniform standards. Nevertheless, we believe there still remains a question of the Interagency Committee's priority and how it fits into the overall program. Until the program has established a strategy, priorities, and goals to achieve the act's objectives and a mechanism to evaluate progress, questions will be raised as to how vital individual program elements, such as the Interagency Committee, are to the success of a unified national program.

Is the program coherent and balanced?

Advisory committees that have studied various aspects of earthquake research and mitigation have agreed on the need to carry out a coherent and well-balanced earthquake program. However, FEMA has not provided guidance to participants on what constitutes such a program. Consequently, participants have differing opinions on the direction of a national program and the relative importance of the primary objectives. While we recognize that such differences will always exist, we believe it is incumbent on the lead agency, in conjunction with the other agencies, to decide on the most appropriate program direction and priorities and then monitor implementation of its decisions.

Our discussions with program participants and review of program documents showed that differences of opinion exist on a range of issues covering both the research and non-research areas. Major differences are discussed in the paragraphs below.

Research versus application of research findings

The program has received criticism from the Congress and some program participants that few of the findings of federally funded research end up being applied to mitigate earthquake hazards. They believe greater efforts are needed to ensure that research is directed to the needs of those who can implement the findings. Program officials from NBS, NSF, and USGS, however,

generally believe that research results have been applied, and the problem may be that these agencies do not do enough to publicize what has been achieved. Nevertheless, neither these agencies nor FEMA has studied this issue from an overall program standpoint to determine the extent of the problem, if any. Our work indicated that some research was being applied, but within the time available, we were not able to assess how much research was being applied in terms of the overall program. In its comments on our draft report (see app. IX), the Department of the Interior agreed that this is an area that should be reviewed.

Research versus preparedness planning

The Federal involvement in the earthquake program has been and still is heavily oriented toward research. Only recently, primarily in response to Federal concerns about the state of readiness to cope with the impact of a catastrophic earthquake in California, have serious efforts been initiated to improve preparedness planning. A report entitled "An Assessment of the Consequences and Preparations for a Catastrophic California Earthquake: Findings and Actions Taken," published by FEMA in November 1980, concluded that current plans and preparedness are clearly inadequate for a catastrophic earthquake, with the likely result that Federal, State, and local response activities would become disorganized and largely fail to perform effectively for an extended period of time. Despite recent efforts to bolster all levels of earthquake preparedness planning, funding for "Preparedness Planning and Hazard Awareness" is less than 3 percent of total program funding, as shown in the September 1982 draft 5-year Program Plan. Without a clear strategy and program priorities, there is no basis to judge the adequacy of funding for preparedness planning.

Earthquake engineering versus prediction

For some 20 years, controversy has been raised over the costs and benefits of improving the capability of structures and lifelines to withstand critical earthquakes compared with developing a capability to predict earthquakes. On the one hand, earthquake-resistant construction standards are seen as having a greater probability of reducing hazards at relatively little cost, while prediction is seen as a gimmick creating unrealistic expectations and having complex socioeconomic ramifications. On the other hand, construction standards are also seen as having little value in dealing with the costly and very difficult problem of inspecting and retro-fitting the many older structures to resist earthquakes, whereas an operational prediction system can more effectively deal with this problem by alerting the occupants to evacuate the premises.

HOW SHOULD THE PROGRAM BE ORGANIZED?

Because of the subcommittee's interest in alternatives to FEMA as the lead agency, we identified several organizational structures for leading and managing the program. For example, during our review, USGS and the Office of Science and Technology Policy (OSTP) were suggested by various program participants as possible "lead" agencies.² However, none of these structures has clear advantages over the current arrangement. We therefore believe that FEMA should be given additional time as lead agency to develop an effective interagency body, and through this body to produce a program plan, a consolidated budget process, and periodic evaluation.

National programs such as the National Earthquake Hazards Reduction Program, involving several Federal agencies and guided by a lead agency, are not uncommon. Nevertheless, the Federal Government has not established criteria as to how such multi-agency programs should be organized and managed. An OSTP Assistant Director told us that establishing criteria is something that has to be struggled with for each multiagency program.

In our opinion, a major responsibility of a lead agency should be to provide guidance and direction to program participants to ensure that resources are efficiently used and program activities serve national as well as agency interests. This, in turn, requires a management system that looks at a program in its entirety rather than as separate, independent segments. For example, one agency may wish to increase funding in its area of responsibility whereas, from an overall program standpoint, improved efficiency and effectiveness may result from allocating those additional funds elsewhere. In order for agencies to be in a position to make such budget decisions, a process must exist to set overall program goals and priorities, allocate program resources, and evaluate program performance.

While there is no best way to organize or manage a multi-agency program, we believe that the program management framework called for by the Earthquake Hazards Reduction Act (see app. II) is generally consistent with the elements we have found in other multiagency national programs. We have issued several reports and provided testimony on management issues associated with multiagency programs. The reports and testimony are listed and summarized in appendix III.

²A detailed discussion of the advantages and disadvantages of each of the single choices for lead agency is in appendix VI.

Although the lead agency should be responsible for ensuring that there is a management system, it does not necessarily have to implement such a system on its own. The lead agency, for example, could create an interagency body to deal with and resolve program issues. This is, in fact, the approach FEMA has recently begun to take through its recently formed Earthquake Policy Review Group.

Alternatives for program leadership fall into two basic types--single agency leader or committee leader. The major advantage of a single lead agency is that a specific entity can be held accountable for program performance. The major disadvantage, in our opinion, is that an aggressive lead agency can produce unrealistic expectations in the long term because, as a practical matter, no lead agency can have complete control over other agencies participating in the program. Also, deciding which agency should be the lead is difficult because often an agency may be more concerned with its own interests than with program needs.

The major advantage of a committee or collegial structure is that it recognizes that a multiagency program is highly dependent on the cooperation of the participating agencies and is, therefore, better guided by a representative group, much like a corporate board of directors. The major disadvantages of committees are the difficulty of fixing responsibility and accountability for performance and, frequently, a lack of authority caused by the assignment of low-level officials to represent their agencies.

An interagency committee as the lead entity for the program could take various forms. The level of the committee can range from a committee of midlevel program officials to a committee of high-level policy officials. The committee can be chaired by one agency, or two or more co-chairs can be named. This structure is used for the Federal acid rain program. The Acid Precipitation Act of 1980 created the interagency Acid Precipitation Task Force to coordinate Federal acid rain research. The task force is responsible for developing a national plan and a consolidated budget for acid rain research. The task force is co-chaired by representatives of the Department of Agriculture, the National Oceanic and Atmospheric Administration (NOAA), and the Environmental Protection Agency.

A variation on the committee approach is to establish an interagency committee, not to serve as the lead but to advise the lead agency. For example, the National Ocean Pollution Planning Act of 1978 designates the National Oceanic and Atmospheric Administration as lead agency for preparing and periodically revising a plan to coordinate and direct Federal ocean pollution research. To advise NOAA in carrying out its mandate,

the Interagency Committee on Ocean Pollution Research, Development, and Monitoring was established.

Another variation on the committee approach would be to establish a committee or interagency group under the direction of the Office of Science and Technology Policy. During the last 6 years, OSTP has participated, as leader or member, on 20 or more such interagency groups involving coordination among agencies with research and development responsibilities and programs. Consequently, OSTP has had experience in connection with administering and planning varied multiagency programs with science and technology components. An OSTP Assistant Director told us that OSTP could fulfill a coordinating role in the program by establishing an interagency committee.

There is a certain amount of flexibility in how organizational arrangements can be established under OSTP. One arrangement is to establish a temporary committee. This allows OSTP and high-level officials from the involved agencies to deal with policy issues requiring immediate attention and then terminate the committee when its purpose is accomplished.

CONCLUSIONS

FEMA's program officials have viewed their role as one which is evolving over time. Although designated as lead agency for the program in July 1979, FEMA did not begin taking major steps to carry out its lead role until mid-1981. FEMA has narrowly defined its role, preferring to function primarily as a coordinator rather than a manager or initiator of an interagency decisionmaking process. Program officials, however, say they now believe they should play a more aggressive leadership role and agree with us that program management should be improved. They have recently instituted an Earthquake Policy Review Group to improve oversight and management of the program. This Group has the potential to become an effective interagency body for implementing a national program as required by law. However, to do so, the Group will have to involve itself in decisions affecting the goals, priorities, budgets, and target dates for the earthquake-related activities of participating Federal agencies.

Largely because FEMA has confined its lead role to coordinating agency activities, it has not carried out a number of responsibilities assigned to it by the President and the act, including interagency planning, budgeting, and evaluation. We believe that FEMA should continue as the program's lead agency because it has the responsibility to respond in the event of an actual earthquake, has a closer relationship with State

and local governments, and is more concerned with the operational application of earthquake mitigation measures. By more aggressively implementing the act's requirements FEMA could better prepare the Nation for the next major earthquake. Proper funding and management attention would be directed to more important projects.

RECOMMENDATION TO THE DIRECTOR, FEDERAL EMERGENCY MANAGEMENT AGENCY

We recommend that the Director, Federal Emergency Management Agency, formalize and strengthen the role of the Earthquake Policy Review Group as the program's oversight and management body by scheduling regular meetings; instituting a process that will bring important issues before it for decision, including establishing program goals, priorities, budgets, and target dates; and requesting, if necessary, specific congressional funding for its activities.

AGENCY COMMENTS AND OUR EVALUATION

We received comments on a draft of this report from FEMA, NSF, NBS, and the Department of the Interior. FEMA provided us with oral comments while the others provided written comments which are contained in appendixes VII, VIII, and IX.

FEMA agreed that the report's contents were factually accurate. FEMA believes that it has made good progress in the last year in carrying out its lead agency role but recognizes that progress needs to be sustained to effectively implement the act's requirements. FEMA maintains that, as a practical matter, its leadership role can be most effectively carried out in a "collegial," or cooperative, manner with the other program participants.

In a draft of this report we had proposed that the FEMA Director put in place an interagency body to develop and implement a National Earthquake Hazards Reduction Program as required by law. In its response to our draft report, FEMA stated that the Earthquake Policy Review Group, initiated in January 1983, would oversee the necessary program planning, budgeting, and evaluation required by the act. We believe that this new Group could develop into an effective interagency body to guide and direct the program. However, this Group is still in its formative stage and has considerable work before it to fulfill the act's requirements. Consequently, now that FEMA has put in place an interagency body intended to oversee and manage the program, we have revised our proposal and are now recommending specific functions for the Policy Review Group to perform as it develops into a viable entity.

We had also proposed that a temporary Office of Science and Technology Policy task force be formed to help FEMA implement a management system of planning, budgeting, and evaluation. We believed that the Office's experience in coordinating other multiagency scientific programs would be useful in putting the earthquake program on a sound footing. FEMA believes that its Policy Review Group, not an OSTP panel, is the most suitable forum for program planning and budgeting. Because FEMA appears on its way to establishing a joint decisionmaking process to deal with overall management and budget issues of the program, we have dropped our proposal for a separate task force. Our main concern is that the program be effectively managed in accordance with the act.

NSF stated that significant advantages can be gained from a collaborative mode of priority setting and decisionmaking among the participating agencies. NSF believes that it and USGS can best manage the program by continuing the present practice of planning, budgeting, and managing the program within each agency, based on the overall priorities established by FEMA and the Earthquake Policy Review Group.

The Department of the Interior agreed that the management of the program should remain with FEMA. Interior did not believe that an ad hoc group under OSTP was needed because an Interagency Coordination Committee already exists to coordinate activities among the Federal agencies. Interior stated that it would not be appropriate to relinquish the budget process to FEMA because the individual agencies are best able to identify and establish budget priorities for their individual programs.

We agree with FEMA, NSF, and Interior that FEMA could provide the necessary guidance and direction for the program through a cooperative interagency approach. Nevertheless the amended act, along with Executive orders, grants FEMA certain lead agency duties for implementing the National Earthquake Hazards Reduction Program. These duties include establishing "goals, priorities, budgets, and target dates for the implementation of the program." Although FEMA can use various methods to carry out these duties and can rely heavily on other agencies for assistance, the ultimate responsibility rests with FEMA.

Regarding Interior's and NSF's concern about our suggested consolidated budget process, such a process need not commit the individual agencies to the level of funding agreed upon during preparation of a program budget by an interagency body. Each agency could still follow its own internal budget procedures in addition to reporting to its own appropriations committees. What a consolidated budget process should do is to provide a

means by which the participating agencies can consider the program as a coherent whole before individual agencies proceed with their respective segments. A consolidated budget process would also allow FEMA to meet the act's requirement that a program budget be established.

CHAPTER 3

ASSISTING STATE AND LOCAL GOVERNMENTS

WITH EARTHQUAKE HAZARDS MITIGATION

FEMA, as part of its regular mission, offers assistance to State and local governments and the private sector in earthquake response and recovery planning and related activities. These efforts are separate from FEMA's lead agency responsibilities under the program. Progress in mitigating the potential impacts of a severe earthquake heavily depends on FEMA's ability to convince State and local governments of the likelihood and seriousness of such an earthquake in their locality and persuading them to prepare for the consequences of an earthquake. This is not an easy job considering that the occurrence of a major earthquake--a low frequency event--cannot be reliably predicted.

Earthquake mitigation and response planning¹ by Federal, State, and local governments has progressed more slowly than projected in the first annual report on the program in 1979. FEMA's most recently projected completion dates indicate several years of delay. This is due, in part, to FEMA's redirection of State and local planning in 1980. Also, reflecting the low priority given the whole program by FEMA, it did not assign staff to Federal response planning until 1982. However, progress in response planning efforts depends not only on FEMA's continued attention to direction of these efforts, but on other Federal agencies and State and local governments preparing the actual plans.

FEMA intends for 12 U.S. locales to complete response and mitigation planning as soon as possible--11 by 1988. FEMA determined those priorities within the context of the particular program objective rather than the overall program. While we do not disagree with planning for locales at risk from a severe

¹Response plans designate organizational elements in charge of each of the various services that would be needed in the event of an emergency, such as fire-fighting, rescue, debris clearance, and communications, and list the procedures to be followed in carrying out the associated responsibilities.

earthquake even where the risk of a severe earthquake is uncertain, we believe decisions allocating funds for such planning should be made within the framework of the overall program's priorities. FEMA has agreed to do this.

FEDERAL RESPONSE PLANNING

Reflecting the whole program's low priority within FEMA, it did not assign staff until 1982 to initiate new plans to develop a comprehensive, federally coordinated response to a catastrophic earthquake. This undertaking's success will depend on FEMA's direction, the cooperation and participation of numerous Federal agencies, and sufficient funding.

Various attempts have been made over the past 10 years to deal with Federal response planning for a catastrophic earthquake. Most national-level attempts and subsequent regional-level efforts were directed toward response to an earthquake in specific locales such as the San Francisco Bay area. Reflecting FEMA's current emphasis on planning, a 1979 San Francisco Bay area Federal response plan is now being replaced by a plan for use anywhere in California to be used in a joint Federal-State test exercise in fiscal year 1984. Regional-level planning efforts have also been directed to specific areas. For example, a regional response plan for the Salt Lake City area was being updated at the time of our review and was to be used in a joint Federal-State exercise in fiscal year 1983. A regional-level response plan has been drafted for the Puget Sound (Washington) area. Regional-level Federal response planning in most other regions is in the formulative stages.

The foregoing regional response plans do not fully take into consideration the potential extent of damage a catastrophic earthquake could cause. In 1980, an ad hoc committee of the National Security Council concluded that current response plans and preparedness measures may be adequate for moderate earthquakes, but State and local resources and existing Federal response mechanisms authorized under disaster legislation cannot accommodate the estimated needs for post-earthquake rescue operations and delivery of assistance and services after a catastrophic earthquake without additional organizational planning and preparation.²

²Assessment of the Consequences and Preparation for a Catastrophic California Earthquake: Findings and Actions Taken, Federal Emergency Management Agency (Washington, D.C., 1980).

As a means of coordinating Federal response planning, FEMA has established a Subcommittee on Federal Earthquake Response Planning under the Interagency Coordination Committee of the National Earthquake Hazards Reduction Program. The Subcommittee met for the first time on August 18, 1982, with representatives in attendance from 10 agencies responsible for immediate life-saving operations. Member agencies of the Committee and other Federal agencies will be involved in the effort as planning development progresses.

FEMA has developed a planning process and approach for a comprehensive national response plan. Planning guidance, developed by FEMA with the assistance of Subcommittee members, was published in the Federal Register in March 1983. The policies and guidelines, concept of operations, and roles and responsibilities of agencies contained in the guidance will be used to prepare operational response plans. Testing of the plans will follow to ensure that all interfaces and coordination aspects have been covered.

The President's Emergency Mobilization Preparedness Board (described in app. IV) is placing increased emphasis on agency planning for "improved national capability to respond to major peacetime and wartime emergencies." The Board established a Working Group on Earthquakes in 1982 to reduce deaths, destruction of property, economic instability and adverse impacts on the Nation's defense capability from a severe earthquake. FEMA is proceeding on the assumption that other Federal agencies' national-level response planning for the Working Group on Earthquakes will stimulate those agencies to respond to FEMA's request for plans.

A summary of a 1982 FEMA in-house conference indicates that FEMA officials believed that one reason Federal agencies did not plan in the past was that earthquake response planning was not a primary mission of most Federal agencies, and therefore it received low priority and no specific staff and funding. This situation is no different today. Adherence to the timetable FEMA proposed for development of plans and test exercises using those plans will depend on FEMA's direction and on the availability of resources from other Federal agencies.

STATE AND LOCAL PLANNING

Planning for earthquake mitigation and response has been evolving over the past 10 years. Federal leadership and financial support for State and local planning have been increasing, but the Federal agencies have passed more responsibility for completing the actual plans to State and

local government also. Since FEMA became the lead agency, it has served as a "stimulator" by providing about \$1.4 million to certain locales for earthquake mitigation planning and response in fiscal years 1981 and 1982. In the September 1982 draft program plan, FEMA proposed to spend an additional \$8.6 to \$12.4 million in fiscal years 1983 through 1987 on these activities.

From 1971 to 1977, planning was geared to aiding and responding to the potential needs of earthquake victims. States were to be primarily responsible for disaster assistance, with the Federal Government providing supplemental aid. In 1978, Federal planners decided that all levels of government should be prepared to respond to earthquake disasters because without a prediction system allowing evacuation and other efforts that would mitigate the impacts of a major earthquake, no single level of government would be able to respond adequately.

In 1979 the Office of Science and Technology Policy, which coordinated initial efforts under the 1977 act, designated 10 heavily populated areas with high seismic risk potential for response planning. The affected States were to assume leadership and responsibility for preparing the risk and damage estimates portion of the vulnerability studies³ and for State and local planning, rather than just State planning as they had done in the past. However, the States were to be the primary responders in the event of a major earthquake, and their plans were to reflect that responsibility.

FEMA redirected earthquake planning efforts in 1980 to make local communities the primary response level, with State and Federal responses being supplementary. Updated vulnerability studies and local mitigation and response plans were to be developed. FEMA anticipates that planning directed to the local level will produce more specific assessments of the survivability of specific hospitals, fire stations, schools, utility

³A vulnerability study consists of two parts: (1) a USGS estimate of the maximum probable severity of an earthquake in a specific seismic risk area and (2) risk and damage estimates--an estimate of the resulting deaths, injuries, and physical damage to critical facilities such as hospitals, transportation routes, rescue services, and utilities.

lines, and so forth. FEMA prefers that mitigation and response plans be developed by local officials and community leaders to ensure they are brought into the planning process.

Table 2 shows, for the 12 currently designated risk areas, the planned or actual completion dates for the vulnerability studies and response plans anticipated by Office of Science and Technology Policy planners in 1979 and FEMA planners in 1982. A comparison of the dates established in 1979 with those estimated in 1982 indicates that completion dates for vulnerability studies and State and local response plans have slipped 1 or more years for several risk areas.

Table 2

Planned or Actual Completion Dates for
Vulnerability Studies and Response Plans

<u>Risk area</u>	<u>As of 1979</u>		<u>As of 1982</u>	
	<u>Vulnerability studies</u>	<u>Response plans</u>	<u>Vulnerability studies</u>	<u>Response plans</u>
Los Angeles	1973 ^a	1980 ^b	1981 ^c	1982 ^a
San Francisco Bay	1972 ^a	1979 ^b	1984 ^c	1985 ^b
Puget Sound	1975 ^a	1981 ^b	1984 ^c	1984 ^b
Salt Lake City	1976 ^a	1979 ^b	1982 ^c	1983 ^b
Anchorage	1980 ^b	1981 ^b	1981 ^a	1984 ^b
Honolulu	1980 ^b	1981 ^b	1980 ^a	1982 ^a
Charleston (South Carolina)	1980 ^b	1981 ^b	1984 ^b	1986 ^b
Boston	1981 ^b	1982 ^b	1983 ^b	1984 ^b
Central U.S.	1981 ^b	1984 ^b	1984 ^b	1986 ^b
Upper New York	1981 ^b	1982 ^b	1986 ^b	1986 ^b
San Diego	(d)	(d)	1985 ^b	1985 ^b
Puerto Rico	(d)	(d)	1985 ^b	1985 ^b

^a Done.

^b Estimated completion date.

^c Update completed or planned completion date.

^d Not planned.

Local preparedness planning

FEMA's efforts to involve local level officials, community leaders, and businessmen in mitigation and response planning began in 1980 with the Southern California Earthquake Preparedness Project. This project's goal is to stimulate preparedness for predicted or unpredicted earthquakes within its five counties--San Bernardino, Riverside, Orange, Ventura, and Los Angeles.

This jointly funded project operates under a cooperative agreement between FEMA and the California Seismic Safety Commission. It is developing comprehensive prototype plans on how an earthquake prediction would be validated and subsequently communicated to public and private officials, how the region would respond to such a prediction, and how to minimize negative impacts of an earthquake warning. Documentation of the processes used in developing these various plans is expected to be transferred to other high-risk seismic areas.

Building on its present knowledge and lessons being learned from the Southern California Earthquake Preparedness Project, FEMA has also defined five tasks which it believes should be part of the local planning process, in addition to the two mentioned previously. The tasks include establishing a local planning council, tests and exercises of the response plans, developing and implementing hazard mitigation programs for special facilities, and identifying recovery and reconstruction mitigation opportunities. Due to regional differences, level of awareness, and unique political climates, FEMA does not expect each task to be carried out in every study area, although it does expect most tasks to be completed. The following table shows scheduled funding, completion dates, and the number of tasks underway and to start for the 12 seismic risk areas.

<u>Seismic risk area</u>	<u>Proposed funding 1983-1987^a</u> (in millions)	<u>Estimated year area will complete</u>	<u>Number of tasks</u>	
			<u>Underway by end of fiscal year 1982</u>	<u>To start in fiscal year 1983</u>
Los Angeles (note b)	.5-.6	1983	6 of 7	1
Anchorage	.1-.2	1984	1 of 4	2
Honolulu	.1-.2	1984	2 of 5	2
Salt Lake City	.2-.4	1985	2 of 5	0
Puget Sound	.5-.7	1986	1 of 6	1
Boston	.4-.5	1986	2 of 6	0
Charleston (South Carolina)	.7-1.1	1987	2 of 6	0
San Francisco	1.1-1.5	1986	0 of 7 ^c	2
Puerto Rico	.3-.6	1986	0 of 6	1
Upper New York	.4-.7	1987	0 of 6	0
San Diego	.4-.6	1987	0 of 7	1
Central U.S.	1.9-2.5	After 1987	1 of 6	0

^aExcludes up to \$750,000 a year for multi-hazard preparedness not yet allocated to specific locales.

^aSouthern California Earthquake Preparedness Project.

^cRefers to updated plans.

While planning had begun in eight of the 12 locales, several have more to do than indicated by the above table. For example, Boston and Charleston had established planning councils and begun vulnerability analyses with no action initiated on the other four tasks. Also, in the central U.S. area which encompasses portions of seven States and 128 counties, vulnerability analyses have begun in only six cities.

Priority-setting could be improved

FEMA did not allocate dollar resources for State and local earthquake response and mitigation planning for the 12 locales within the context of the overall earthquake program objectives and priorities. While we agree State and local planning should proceed given the uncertainties of the occurrence of severe earthquakes and the risk of not proceeding with planning, funds may not always be available for planning for all of the locales considered to be at risk and to accomplish all of the other program requirements. At that point, decisions should be made within the framework of the overall program's priorities.

In setting priorities for planning among the locales, FEMA considered only whether an area was considered to be at risk. It did so because timing of earthquake occurrences cannot be reliably predicted.

While uncertainties do exist as to when and where an earthquake will occur, the scientists estimate the probability of a severe earthquake occurring in a given locale in any given year based on known historic earthquakes and geological research. For example, USGS estimated that there is a 0.1-percent chance of a damaging earthquake the size of the 1886 Charleston earthquake anyplace along the eastern seaboard including Boston in any given year. The 1811-12 New Madrid, Missouri, earthquakes --the most severe known in the United States--are estimated by USGS scientists to have recurrence levels of from 300 to 900 years. In contrast, Southern California is estimated to have a 50 percent probability of experiencing a severe earthquake within the next 30 years. Such estimates could provide additional information for FEMA's use in prioritizing program needs.

CONCLUSIONS

Progress in mitigating earthquakes depends heavily on FEMA's (1) convincing State and local governments and private concerns of the likelihood of and seriousness of potential effects of a major earthquake in a given locality and (2) persuading them to prepare for such an event. Planning for mitigation and response by Federal, State, and local governments has not progressed as quickly as originally estimated.

Adherence to FEMA's schedule for developing response plans by Federal agencies and the related test exercises will depend on FEMA's attention to direction of these efforts and the availability of resources and support from other Federal agencies for which earthquake response planning has been a low priority in the past.

State and local government planning for earthquake mitigation has been evolving in the past 10 years with the Federal Government placing more responsibility for those planning efforts on State and local governments. In addition, FEMA redirected earthquake planning efforts in 1980 to make local communities, instead of the States, the primary responder to a major earthquake; State and Federal responses would now be supplementary to local efforts. FEMA is also placing more emphasis on mitigation. Due to these changes, some earlier planning efforts need to be updated and much remains to be done.

Because of the uncertainty associated with the occurrence of earthquakes, we agree that State and local response and mitigation planning should proceed as planned in the 12 areas, but believe that decisions allocating funds for such planning should be made within the context of the overall earthquake program's objectives and priorities. FEMA, in response to a proposal in our draft report, has agreed to consider funding for response and mitigation planning within this broader context. We therefore offer no recommendation to FEMA in this chapter.

CHAPTER 4

OPERATIONAL EARTHQUAKE PREDICTION SYSTEM:

PRIORITY FOR DEVELOPMENT UNDETERMINED

A reliable prediction of an imminent major earthquake could provide incalculable benefits in terms of lives saved and injuries avoided. Disruption and property damage might also be reduced if the onset of an earthquake could be reliably predicted. The estimated cost of \$100 million or more for a prediction system for a single geographical area may be small when compared with the aggregate economic impact of deaths, injuries, disruption, and property damage that could result from an unexpected earthquake. The Congress recognized this when it made implementation of a system for predicting earthquakes an objective of the earthquake program.

However, more than 5 years after the act's passage, advances in technology and in our basic knowledge of earthquakes which would have made such a system feasible have not occurred. An operational prediction system is not in place, although USGS is studying the requirements for one.

Although the potential benefits may be substantial, considerable uncertainty exists about the prospects for successfully implementing an operational prediction system. USGS officials and others question

- whether such a system could make reliable, short-term predictions and

- whether scientists know enough about the fundamental nature of earthquakes to develop such a system.

FEMA, as the program's lead agency, has not initiated a process to establish the priority a prediction system should have relative to other program objectives. The agencies participating in the program, under FEMA's sponsorship, need to reach a decision on the level of priority to assign the development of an earthquake prediction system relative to other program objectives, such as preparedness planning or research to develop earthquake-resistant construction standards. If it is found vital to our Nation's disaster preparedness and if the agencies judge that scientific problems can be overcome, then USGS and FEMA should vigorously promote adequate funding for the system's development.

EARLY OPTIMISM FADES

One objective of the Earthquake Hazards Reduction Act of 1977 was

"* * * the implementation in all areas of high or moderate seismic risk, of a system (including personnel, technology, and procedures) for predicting damaging earthquakes and for identifying, evaluating, and accurately characterizing seismic hazards."

We found that the existing USGS earthquake monitoring system, developed for research purposes, has not evolved into a prototype earthquake prediction system as was envisioned in 1977.

Many scientists now concede that at the beginning of the program there were unrealistic expectations for the prospects for reliable, short-term prediction of earthquakes. However, some believe progress has been made in intermediate and long-term prediction.¹ In 1977, it was widely believed that a major commitment of funds and scientific talent could result in an operational earthquake prediction capability within a few years. There does appear to be a sense of optimism concerning the long-term prospects for understanding and, consequently, predicting earthquakes, but some scientists now believe that continuous advances will take place with no quick and easy solution to the problem. In a written response to questions we asked during this review, the USGS scientist in charge of the earthquake prediction program described the scientific problems in developing an earthquake prediction capability as follows:

"* * * earthquake prediction is not a fully developed subject that can be implemented by simply employing existing engineering principles. The physical processes that culminate in an earthquake are generally

¹There is no standard definition of "short-term," "intermediate," and "long-term" with respect to earthquake predictions. With respect to the probability of a damaging earthquake occurring, the Southern California Project has tentatively defined a "short-term prediction" as having a 50 to 100 percent chance of occurring within 10 days, and "long-term prediction" as having less than a 10 percent chance of occurrence per year. An "intermediate-term prediction" has a 10 to 100 percent chance of occurring per year.

hidden from direct view and are possibly as complicated and subtle as the processes that control weather. Moreover, the physical laws governing earthquake occurrence are not as well understood as those governing the weather. Finally, inadequate high quality data is available to test theories. Because the time scale of the processes is very long, the collection of high quality data requires a dedicated long-term effort.* * *

ELEMENTS OF AN EARTHQUAKE PREDICTION SYSTEM

A historical record, or baseline data, is a prerequisite for attempts to predict earthquakes. This, coupled with basic research into the mechanics of earthquake phenomena, would allow for an interpretation of the data collected by an earthquake prediction monitoring system. The monitoring system would be connected to an on-line computer system which would perform the initial reduction of the data for analysis and evaluation by staff scientists. The on-line system would also scan incoming data with a complex program model and, when certain parameters were exceeded, would give some type of prediction and flag the data for immediate evaluation and action.

CURRENT MONITORING EFFORTS

USGS has concentrated its earthquake research monitoring in California. It operates a seismic network center in Menlo Park, California, which covers the northern and central area of the State, and provides major funding for a Southern California seismic network operated cooperatively by the California Institute of Technology at Pasadena, California, and USGS. The northern/central network has approximately 300 seismograph stations, and its computers can automatically locate and measure the intensity of events within minutes of their occurrence. Detailed analysis of seismic events is not yet automated. The Southern California network has approximately 210 stations, and while it currently cannot automatically locate and measure seismic events, most detailed analysis is automated. These stations, which utilize seismometers for recording earthquake signals and various geophysical devices for measuring crustal deformation, are connected to their respective central terminals, most via telephone line telemetry links. Stations located near the boundary of the two networks are linked to both networks.

A USGS official informed us that USGS hopes to incorporate real-time processing into the Southern California seismic monitoring network and automate detailed analysis in the northern/central network with 1983 funds.

SHOULD FUNDS GO TO BASIC
RESEARCH OR AN OPERATIONAL
PREDICTION SYSTEM?

The allocation of resources between research and prediction efforts appears to be somewhat controversial. Given limited program funding, there appears to be a consensus within the scientific community that in the long term, to reach routine earthquake prediction capability, funds at this point in the program would be most effectively spent on basic scientific research, rather than on operational prototype prediction efforts. For example, some scientists contend that data received by an extensive prediction system, while of great value for research purposes, may have only limited utility for predicting earthquakes if valid interpretations of the data are not yet available. They contend that earthquake phenomena are not understood well enough to fully implement a prototype prediction system.

Not surprisingly, however, some officials with public policy responsibilities for response planning and/or responding to earthquake predictions, or the events themselves, believe it is appropriate to place greater emphasis on developing an operational prediction system.

The head of USGS' earthquake prediction program told us that he personally believes that the available limited funding would, in the long term, be most effective if allocated to basic research. However, he also told us:

"* * * I share the widespread judgment that at least some and possibly most damaging earthquakes are predictable with current developments in instrumentation and evaluation procedures. That judgment in conjunction with the very high probability for catastrophic earthquakes in some regions, especially southern California, points to a critical need to actively pursue operational earthquake prediction."

He cited FEMA estimates of 3,000 to 14,000 deaths; 12,000 to 55,000 injuries requiring hospitalization; and property damage of \$17 billion resulting from a major earthquake on Southern California's San Andreas Fault as reason enough to pursue a prediction capability. He stated that the situation is perceived with a sense of urgency within USGS because of the high probability of a major earthquake occurring within the next few decades and the long lead time required to implement an operational system.

FUNDING CUTS COULD JEOPARDIZE MONITORING PROGRAM

The question of whether to fund even one operational prediction system may be premature. Funding for USGS' efforts to collect and interpret baseline seismic data to support development of such a system for Southern California faces an administration-proposed reduction for fiscal year 1984 which could adversely affect data gathering efforts. In addition, USGS' actual funding since 1978 for seismic data gathering has not kept up with inflation and has prevented USGS from expanding its limited research efforts in other locales which might also benefit from an earthquake prediction system.

USGS had based planning for its earthquake prediction program on the median funding level proposed in the Newmark-Stever report,² which preceded the program. By USGS projections, using an average 8.45-percent inflation factor per year, the effective funding in first-year program dollars has been as follows:

²The "Newmark-Stever Report" is the informal title given to the September 1976 study titled "Earthquake Prediction and Hazard Mitigation Options for USGS and NSF Programs," a joint effort of several Federal agencies and the Advisory Group on Earthquake Prediction and Hazard Mitigation. This document presented a plan with options for augmenting the earthquake-related research programs of USGS and NSF. It is still the principal guide USGS uses in planning its prediction research.

Table 3

Comparison of Actual Prediction Budgets
With Inflation-Adjusted Newmark/Steever Budget

	<u>Fiscal year</u>					
	<u>1978</u>	<u>1979</u>	<u>1980</u>	<u>1981</u>	<u>1982</u>	<u>1983</u>
Newmark-Steever median funding level adjusted for inflation (1978 base year) (note a)	\$15.8	\$17.1	\$18.6	\$20.2	\$22.9	\$23.7
Available funding (note a)	\$15.8	\$15.9	\$15.6	\$15.6	\$15.6	\$15.6
Available funding as a percentage of Newmark-Steever median funding level	100	93	83	77	68	66

^aIn millions of dollars.

Source: U.S. Geological Survey.

The President's 1984 budget proposes a cut in USGS' budget which would translate into the same \$2 million cut in USGS' monitoring activity initially proposed for 1983. When faced with the possibility of a \$2 million cut in fiscal year 1983 monitoring activity funds, USGS officials calculated the impacts on USGS monitoring efforts in California in terms of the reduced quantity of data-gathering equipment that would be operated. For example, fault creepmeters which measure minute movements of land on adjacent sides of a fault would be reduced by 20 percent. Below are examples of the reductions for three of six types of equipment affected.

Table 4

Geophysical Deformation Monitoring Activity

	<u>Operational in FY 79</u>	<u>Reduced activity</u>	<u>Percentage decrease</u>
Geodetic survey lines	1,391	1,078	23
Fault creepmeters	49	39	20
Surface strainmeters	7	4	43

Source: U.S. Geological Survey.

Such reductions would have severely cut current monitoring efforts, according to USGS officials. Baseline data, vital for achieving an understanding of earthquake phenomena and a prerequisite for a future prediction system, would have been irrevocably lost as instruments to gather data were shut down or simply not used to measure or record.

In addition, USGS officials had planned to greatly reduce or terminate seismic monitoring and research networks in Alaska and in the California/Mexico border area. The 1983 funds were not cut by the Congress and the reductions in monitoring activity did not take place. But a USGS official said the effect of a 1984 budget cut on operations would be about the same. A USGS official also informed us that, because USGS' monitoring budget has not kept up with inflation, geophysical baseline data in other areas of seismic risk (such as the Salt Lake City region, the midcontinent area in the vicinity of the 1811-12 New Madrid earthquakes, the Puget Sound region, and the eastern United States) is not being collected--data that is necessary to support future prediction activities in these areas.

WHAT IS NEEDED TO ACHIEVE EARTHQUAKE
PREDICTION CAPABILITY?

At the time of our review, USGS officials were developing a conceptual plan to expand the existing earthquake monitoring system into a fully operational prototype prediction system for the Southern California/San Andreas Fault area. USGS tentatively estimates that it would require an expenditure of from \$60 million to \$100 million or more over a 5-year period to upgrade the existing monitoring system and add more monitoring sites in this area alone.

The existing seismic network would be made more stable and telephone wire telemetry links would be replaced by microwave communications. These improvements would lessen the likelihood that a precursor earthquake would disable monitoring stations, thereby "blinding" the system at the time it would be most needed.

The crustal deformation network would be expanded by the addition of some 30 to 50 cluster site studies. These sites would contain borehole strainmeters to detect strains in the earth's crust and two-color laser distance-measuring devices to detect minute movements between two points.

With respect to the current difference in benefits between the in-place research monitoring systems in California and a prototype operational prediction system, a USGS official informed us that the research systems are less expensive because fewer monitoring instruments are used than would be by an operational system. Research systems also provide somewhat more flexibility because a particular type of instrument can be dropped if it is unsatisfactory or does not provide useful data. An operational prediction system would provide more data and do so automatically, both for making earthquake predictions as routinely as weather forecasts are made and for researchers. The in-place research system could produce warnings that geological conditions suggest an impending earthquake.

CONCLUSIONS

The United States does not now have an operational earthquake prediction system as envisioned by the Earthquake Hazards Reduction Act of 1977. Technological advances which would have made such a system feasible have not occurred, so that a system has not been developed by program participants, although USGS is studying the requirements for one.

Although the potential benefits of a prediction system could far outweigh its estimated cost of \$100 million or more per area, there are significant concerns regarding its reliability for making short-term predictions without more basic research. Further, less expensive, less extensive monitoring systems currently in place in California, primarily for research purposes, could produce warnings although not routine prediction of earthquakes.

From the standpoint of the program's overall goals and priorities, FEMA and the other participating agencies need to establish the relative priority that development of an operational prediction system should have.

RECOMMENDATION TO THE DIRECTOR,
FEDERAL EMERGENCY MANAGEMENT AGENCY

We recommend that the Director, Federal Emergency Management Agency, through the interagency body, determine the level of priority that should be assigned to achieving advances in technology and knowledge necessary to make a prediction system feasible. This determination should weigh the costs and uncertainties of a prediction system against the potential benefits of reducing loss of life and injuries as well as reducing property damage and disruption. If it is decided that development of an operational system is vital to our Nation's disaster preparedness and scientific and other problems can be overcome, then the Federal Emergency Management Agency and the Geological Survey, through the National Earthquake Hazards Reduction Program, should seek to arrange adequate funding for its development.

AGENCY COMMENTS AND OUR EVALUATION

FEMA agreed to use its newly formed Earthquake Policy Review Group, a collegial body, to assess the level of priority for developing an operational prediction system, as well as other program objectives as a part of the Group's oversight of program planning, budgeting, and evaluation required by the act. We believe FEMA's proposed action is consistent with our recommendation.

The National Bureau of Standards and National Science Foundation had no comments on this recommendation. The Department of the Interior said that USGS believes implementing a prototype operational earthquake prediction system is still premature for generally the same reasons already cited in the report. The Department also noted seven related issues meriting further consideration before large expenditures are made to implement a prototype system. The issues included questions on the level of financial commitment needed to pursue the developmental research, potential funding sources for such research, and the economic costs and benefits of predictions. We agree with the need to address these issues before implementing a prototype operational prediction system.

OBJECTIVES AND RESEARCH AND MITIGATIONELEMENTS OF THE EARTHQUAKE HAZARDSREDUCTION ACT OF 1977, AS AMENDEDOBJECTIVES AS STATED IN SEC. 5(c):

"(1) the development of technologically and economically feasible design and construction methods and procedures to make new and existing structures, in areas of seismic risk, earthquake resistant, giving priority to the development of such methods and procedures for nuclear power generating plants, dams, hospitals, schools, public utilities, public safety structures, high occupancy buildings, and other structures which are especially needed in time of disaster;

(2) the implementation in all areas of high or moderate seismic risk, of a system (including personnel, technology, and procedures) for predicting damaging earthquakes and for identifying, evaluating, and accurately characterizing seismic hazards;

(3) the development, publication, and promotion, in conjunction with State and local officials and professional organizations, of model codes and other means to coordinate information about seismic risk with land-use policy decisions and building activity;

(4) the development, in areas of seismic risk, of improved understanding of, and capability with respect to, earthquake-related issues, including methods of controlling the risks from earthquakes, planning to prevent such risks, disseminating warnings of earthquakes, organizing emergency services, and planning for reconstruction and redevelopment after an earthquake;

(5) the education of the public, including State and local officials, as to earthquake phenomena, the identification of locations and structures which are especially susceptible to earthquake damage, ways to reduce the adverse consequences of an earthquake, and related matters;

(6) the development of research on--

- (A) ways to increase the use of existing scientific and engineering knowledge to mitigate earthquake hazards;
- (B) the social, economic, legal, and political consequences of earthquake prediction; and
- (C) ways to assure the availability of earthquake insurance or some functional substitute; and

(7) the development of basic and applied research leading to a better understanding of the control or alteration of seismic phenomena."

RESEARCH ELEMENTS AS STATED IN SEC. 5(e).

"(1) research into the basic causes and mechanisms of earthquakes;

(2) development of methods to predict the time, place, and magnitude of future earthquakes;

(3) development of an understanding of the circumstances in which earthquakes might be artificially induced by the injection of fluids in deep wells, by the impoundment of reservoirs, or by other means;

(4) evaluation of methods that may lead to the development of a capability to modify or control earthquakes in certain regions;

(5) development of information and guidelines for zoning land in light of seismic risk in all parts of the United States and preparation of seismic risk analyses useful for emergency planning and community preparedness;

(6) development of techniques for the delineation and evaluation of the potential effects of earthquakes, and their application on a regional basis;

(7) development of methods for planning, design, construction, rehabilitation, and utilization of manmade works so as to effectively resist the hazards imposed by earthquakes;

(8) exploration of possible social and economic adjustments that could be made to reduce earthquake vulnerability and to exploit effectively existing and developing earthquake mitigation techniques; and

(9) studies of foreign experience with all aspects of earthquakes."

MITIGATION ELEMENTS AS STATED IN SEC. 5(f):

"(1) ISSUANCE OF EARTHQUAKE PREDICTIONS.--The Director of the United States Geological Survey is hereby given the authority, after notification of the Director, to issue an earthquake prediction or other earthquake advisory as he deems necessary. For the purposes of evaluating a prediction, the National Earthquake Prediction Evaluation Council shall be exempt from the requirements of section 10(a)(2) of the Federal Advisory Committee Act. The Director shall have responsibility to provide State and local officials and residents of an area for which a prediction has been made with recommendations of actions to be taken;

(2) the development of ways for State, county, local, and regional governmental units to use existing and developing knowledge about the regional and local variations of seismic risk in making their land use decisions;

(3) the development and promulgation of specifications, building standards, design criteria, and construction practices to achieve appropriate earthquake resistance for new and existing structures;

(4) an examination of alternative provisions and requirements for reducing earthquake hazards through Federal and federally financed construction, loans, loan guarantees, and licenses;

(5) the determination of the appropriate role for insurance, loan programs, and public and private relief efforts in moderating the impact of earthquakes;

(6) dissemination on a timely basis, of--

(A) instrument-derived data of interest to other researchers;

- (B) design and analysis data and procedures of interest to the design professions and to the construction industry; and

- (C) other information and knowledge of interest to the public to reduce vulnerability to earthquake hazards;

(7) transmittal to Congress by the Director [of FEMA] of an intraagency coordination plan for earthquake hazard mitigation and response within thirty days after enactment of this paragraph, which plan shall coordinate all the directorates of the Agency; and

(8) the development and implementation by the Director [of FEMA] of a preparedness plan for response to earthquake predictions which includes the following items:

- (A) A prototype plan to be in place in one major metropolitan area by September 30, 1981.

- (B) An action plan to be completed for specific adaptations of the prototype plan to other high risk metropolitan areas by September 30, 1981.

- (C) These prediction response plans are to be integrated with preparedness response plans.

- (D) The plans shall include coordination with State and local governmental companion efforts.

- (E) The plans shall be updated as new, relevant information becomes available."

PROGRAM FUNCTIONS REQUIRED BY THE EARTHQUAKEHAZARDS REDUCTION ACT OF 1977, AS AMENDED

1. Administration: Section 5(a)(1) states that the National Earthquake Hazards Reduction Program shall "be designed and administered to achieve the objectives set forth * * *" in the act. Section 5(a)(3) adds that the program shall include each of nine research elements and eight mitigation elements¹ described in subsections 5(e) and 5(f).
2. Assignment of Responsibilities: Sections 5(b)(1)(A) and 5(b)(2)(A) state that the Director of the Federal Emergency Management Agency (FEMA) shall recommend and the President² shall assign and specify "* * * the role and responsibility of each appropriate Federal * * * agency * * * with respect to each object and element of the program." Section 5(b)(2)(F) states that the Director of FEMA shall "recommend appropriate roles for State and local units of government, individuals, and private organizations."
3. Goals, Priorities, Budgets, and Target Dates: Sections 5(b)(1)(B) and 5(b)(2)(B) state that the Director of FEMA shall recommend, and the President shall establish, "* * * goals, priorities, budgets, and target dates for implementation of the program."
4. Staffing: Section 5(b)(2)(D) states that the Director of FEMA shall "provide for qualified and sufficient staffing for the program and its components."
5. Program Plan: Section 5(b)(2)(E) states that the Director of FEMA shall "compile and maintain a written program plan for the program specified in subsection (a), (e), (f), and (g) * * * which plan will recommend base and incremental budget options for the agencies to carry out the elements and programs specified * * *."

¹The research elements and mitigation elements are listed in appendix I.

²The act, as amended, requires that the Director of FEMA and the President carry out certain duties. Executive Order 12148, dated July 20, 1979, as amended by Executive Order 12381, dated September 8, 1982, delegated all functions vested in the President by the Earthquake Hazards Reduction Act of 1977, as amended, to the Director of FEMA.

6. Participation: Section 5(b)(2)(C) states that the Director of FEMA shall "provide a method for cooperation and coordination with, and assistance (to the extent of available resources) to, interested governmental entities in all States, particularly those containing areas of high or moderate seismic risk." Section 5(h) provides further elaboration by stating that the President shall "* * * provide an opportunity for participation by the appropriate representatives of State and local governments, and by the public, including representatives of business and industry, the design professions, and the research community, in the formulation and implementation of the program." Section 5(d) provides guidance on which Federal departments, agencies, and entities the President may wish to assign a role in the program.
7. Review and Evaluation: In Section 5(h) the act requires that the non-Federal participation include "* * * periodic review of the program plan, considered in its entirety * * *." In Section 6, the act states that the "* * * President shall * * * submit an annual report * * * describing the status of the program, and describing and evaluating progress achieved during the preceding fiscal year in reducing the risks of earthquake hazards." Section 2(10) also states as a finding of Congress that an "* * * effective Federal program in earthquake hazards reduction will require input from and review by persons outside the Federal Government * * *."
8. Coordination: Section 5(b)(2) states that FEMA is "designated as the agency with the primary responsibility to plan and coordinate" the program. Coordination is not defined.

SUMMARY OF SELECTED GAO REPORTSAND TESTIMONY ON MULTIAGENCY FEDERAL PROGRAMS

1. "Need To Strengthen Coordination of Ocean Pollution Research" (GAO/CED-82-108, July 14, 1982).

The National Ocean Pollution Planning Act of 1978 designates the National Oceanic and Atmospheric Administration (NOAA) as the lead agency for preparing and periodically revising a plan to coordinate and direct Federal ocean pollution research--an activity scattered throughout the Government. We found that although NOAA has made progress toward implementing the act, the plan has had little impact on ocean pollution research.

In our opinion, a major function of an interagency coordination effort should be to ensure that research serves national as well as agency interests. We concluded that NOAA's efforts to improve interagency coordination have been limited by (1) NOAA's inability to influence research in other Federal agencies and (2) a lack of clear direction in the 5-year plan on how Federal research money should be spent and on how research responsibilities should be allocated among agencies.

We recommended that the National Ocean Pollution Planning Act be amended to increase NOAA's or an appropriate interagency committee's ability to coordinate research and that future revisions of the plan provide clearer direction for the course and organization of the Federal research effort.

2. "The Federal Government Needs a Comprehensive Program To Curb Its Energy Use" (EMD-80-11, Dec. 12, 1979).

This report found that the Federal Government's program to conserve energy was in disarray. In spite of legislative and executive guidance, a comprehensive, aggressive energy conservation program for the Federal sector had not been developed. While individual agencies had made some progress in conserving energy, these efforts were fragmented and piecemeal because the Department of Energy had not taken an active leadership role.

This report included recommendations to (1) clearly define agency roles, authority, and responsibilities, (2) provide to the Department of Energy central funding and control over energy conservation funds, (3) define the priority that agencies are to place on energy conservation and assign the Department of Energy's responsibility for the Federal Energy Management Program, and (4) establish within the Department of Energy a

high-ranking Federal Energy Management Program office with broad responsibility for Federal sector energy conservation plans.

3. "The Need for a National Ocean Program and Plan"
(GGD-75-97, Oct. 10, 1975).

This report disclosed that the United States had no comprehensive national ocean program. Federal marine science and other oceanic activities were conducted by 21 organizations in 6 departments and 5 agencies. The report raised doubts as to whether the resources of the 11 departments and agencies were being applied to best serve national purposes.

We concluded that, because of the vital role the oceans play in the Nation's economy and national security, a concerted effort should be undertaken to establish a national ocean plan and program. Such a program should (1) identify marine-related needs and establish specific national objectives, (2) establish priorities to accomplish these objectives, (3) evaluate program results, including relevance to national needs, (4) periodically update needs, objectives, and priorities, and (5) provide for adequate funds to effectively carry out the plan and program.

4. "Federal Materials Research and Development: Modernizing Institutions and Management" (OSP-76-9, Dec. 2, 1975).

This report found that the Government had no overall Federal materials research and development (R&D) program but, rather, a large number of specific mission-oriented R&D activities. In fiscal year 1974, 23 agencies had 90 subdivisions sponsoring materials R&D. It would be incorrect to conclude that the sum of these activities constitutes a viable national program.

The report concluded that a national materials R&D program cannot be formulated without a definition of basic objectives of national materials policy. R&D efforts can then be directed to support policy objectives. Also, no system had been established for assigning priorities to actions toward achieving national materials goals. And there was no established institutional capability to assess alternatives and tradeoff considerations between potential actions.

We recommended that the Congress consider establishing an institution to analyze national materials issues and provide policy guidance on a continuing basis.

5. "Statement of the Comptroller General of the United States before the Subcommittee on Domestic and International Scientific Planning and Analysis of the House Committee on Science and

Technology on Coordination of Government Research and Development," July 20, 1976.

The Comptroller General discussed the four aspects and ingredients of effective central coordination, which include:

- Participation in R&D budget planning and analysis to examine resource allocations in relation to national goals and priorities, including early recognition of opportunities and anticipation of future needs.
- Interagency comparison of potentially related Federal programs to identify incompatibilities, unnecessary duplication, and insufficient coverage.
- Analysis of functional crosscutting issues, policy questions, and R&D administration matters not intrinsically related to any single program but generally pervasive of all efforts involving science and technology.
- Analysis of needs and involvement of users in the R&D planning process to assure coupling between R&D performers and ultimate users, and to facilitate technology delivery and utilization. The needs of users in both the Government and the private sector should be considered as appropriate, and different mechanisms may be needed in each case.

Effectiveness of a coordinating mechanism depends on five essential ingredients:

- It requires highly qualified people with differing disciplines and experience.
- It must have adequate resources available to cope with the issues involved in a timely manner.
- Its charter and authority should be clearly defined.
- Its report should present the issues and recommendations involving science and technology in the context and terms of socioeconomic and political decision alternatives.
- Finally, it must have a clearly identified customer with implementing authority to whom it may address its recommendations.

6. "A More Comprehensive Approach Is Needed To Clean Up the Great Lakes" (CED-82-63, May 21, 1982).

This report states that the Environmental Protection Agency, the lead U.S. agency for carrying out water quality activities and implementing the Great Lakes Water Quality Agreement, has broad and complex responsibilities requiring it to work and cooperate with a variety of Federal, State, and local agencies as well as the International Joint Commission and Canadian environmental agencies. The Environmental Protection Agency's Great Lakes National Program Office has had difficulty obtaining the cooperation needed from other Federal agencies and the States because it does not have the visibility, authority, and resources needed to assure that its Great Lakes water quality program can compete with other important national issues.

We concluded that the numerous programs and measures called for in the agreement, and the multitude of entities involved in carrying them out, require that a high-level office have the authority and the resources needed to oversee and coordinate the activities of the various agencies involved.

7. "Progress Made in Federal Human Nutrition Research Planning and Coordination; Some Improvements Needed" (CED-82-56, May 21, 1982).

This report provided an overview of the progress made to coordinate Federal nutrition research efforts and identified some areas needing improvement.

We found that the Government has no overall Federal nutrition plan that identifies specific goals with unified and coordinated strategies. However, the Departments of Agriculture and Health and Human Services, along with the Office of Science and Technology Policy, have set the groundwork for a coordinated planning system. Nine Federal departments and agencies, covering diverse areas such as nutrition research, food regulations, education, and information, have been working together to facilitate communication and effective and efficient use of resources.

PRINCIPAL COMMITTEES, ORGANIZATIONS, PANELS AND
OTHER MECHANISMS PROVIDING FOR COORDINATION
AMONG EARTHQUAKE PROGRAM PARTICIPANTS

EARTHQUAKE POLICY REVIEW GROUP

In January 1983 FEMA established this interagency Group of policy-level officials from the four principal Federal agencies participating in the earthquake program. The purpose of this Group is to deal with overall program policy issues. FEMA intends that this Group oversee the necessary program planning, budgeting, and evaluation.

INTERAGENCY COORDINATION COMMITTEE

This Committee was established by FEMA in 1981 to coordinate the activities of all participants in the National Earthquake Hazards Reduction Program (NEHRP) to ensure that they are in consonance with the program's objective of reducing the risks to life and property from future earthquakes in the United States. The Committee advises FEMA on all earthquake-related matters affecting NEHRP.

All Federal departments/agencies that conduct programs to prepare for, respond to, recover from, and mitigate the effects of earthquake-related hazards may participate. Each department/agency is represented by a designated mid-level official or that official's designee. The Committee's chairperson is the FEMA representative.

INTERAGENCY COORDINATION COMMITTEE'S
SUBCOMMITTEE ON FEDERAL EARTHQUAKE
RESPONSE PLANNING

The interagency subcommittee was created to assist in the coordination of activities necessary for developing a Federal-level response plan for catastrophic earthquakes. The interagency subcommittee consists of Federal departments/agencies that are major sources of disaster assistance under their own statutory authorities, or under the authority of Public Law 93-288 in a presidentially declared major disaster. The subcommittee's chairperson is from FEMA.

EMERGENCY MOBILIZATION PREPAREDNESS BOARD'S
EARTHQUAKE WORKING GROUP

President Reagan established the Board on December 17, 1981, to ensure our Nation's capability to respond effectively

to major peacetime and wartime emergencies. The Board consists of the representatives of 23 key Federal departments, agencies, and executive offices. Chaired by the Assistant to the President for National Security Affairs, the Board is tasked to develop overall policy and a plan of action that will improve the Nation's preparedness capabilities. The Board has the authority to resolve mobilization preparedness issues within the framework of current administration policy. Any issue which cannot be resolved through this process will be referred to the National Security Council for resolution and Presidential decision. The Board is supported by 12 working groups, each responsible for a specific area of preparedness and chaired by an Assistant Secretary-level official from one of the member agencies. One of these working groups is the Earthquake Working Group chaired by the Office of Science and Technology Policy with membership from the various Federal agencies involved in earthquake-related activities.

INTERAGENCY COMMITTEE ON SEISMIC SAFETY IN CONSTRUCTION

This Committee is composed of 17 Federal departments and agencies engaged in construction, the financing of construction, or related activities. The members are to develop seismic design standards for Federal building construction. FEMA is responsible for providing leadership to the Committee, although an NBS official is currently serving as the Chairman.

BUILDING SEISMIC SAFETY COUNCIL

The Building Seismic Safety Council was formed in 1979 under the auspices of the National Institute of Building Sciences. The National Institute was created by the Congress (Public Law 93-383) to provide an authoritative source of findings and advice to the public and private sectors in achieving nationally acceptable standards for Federal, State, and local housing and building regulations. The Building Council provides a national forum to foster improved seismic safety provisions for the design, construction, and use of buildings.

The Building Council has a membership of about 60 organizations in the construction industry, including the Interagency Committee on Seismic Safety in Construction.

USGS EARTHQUAKE STUDIES ADVISORY PANEL

This panel of 12 members, appointed by the Secretary of the Interior, was established to advise the USGS Director on the feasibility and scientific value of USGS' earthquake studies

program. The panel meets twice a year to review program objectives and progress. It can also make recommendations on possible directions and changes in current efforts. The panel membership consists of representatives from several scientific and engineering disciplines, from State governments, and from industry. None of the panel members is a USGS employee.

NATIONAL EARTHQUAKE PREDICTION EVALUATION COUNCIL

In 1981 the USGS Director established the Council consisting of 12 members who are experts in scientific disciplines related to earthquake prediction. At least one-half of the members are not USGS employees; the chairman cannot be a USGS employee. The Council meets at least once a year for administrative purposes and for reviewing progress in the field of earthquake prediction. The Council is designed to aid the USGS Director in evaluating and issuing earthquake predictions.

INTERAGENCY GEOPHYSICS DISCUSSION GROUP

This informal group is about 15 years old and meets monthly. Federal agencies involved with NEHRP belong to the group. These meetings provide a forum for individuals to freely exchange information and discuss ideas. No minutes are kept.

UNIVERSITIES COUNCIL FOR EARTHQUAKE ENGINEERING RESEARCH

Recognizing that university research has certain unique features which distinguish it from similar activity in nonuniversity-connected laboratories, the Universities Council was formed to provide a vehicle for the free exchange of information on university research plans, priorities, and programs, and to assist by whatever means possible in the coordination of university research efforts. NSF supports the Universities Council's activities. The Universities Council organizes periodic meetings of research investigators in earthquake engineering. All university research investigators with an active interest in earthquake engineering are welcome to participate in the Council's activities.

ADVISORY COMMITTEE TO NSF's DIVISION OF EARTH SCIENCES

This committee consists of two parts--a group to evaluate proposals (the panel) and what is called the Advisory Committee. The latter group meets about once a year to discuss broad issues affecting the sciences (e.g., instrumentation,

future directions, budgets, and emphasis) and advise NSF of its views. A subcommittee of the Advisory Committee, with the help of others, reviews each program every 3 years in order to see that the program is being properly managed and that decisions are fair and well considered.

ADVISORY COMMITTEE ON NSF'S DIVISION OF
CIVIL AND ENVIRONMENTAL ENGINEERING,
SUBCOMMITTEE ON EARTHQUAKE HAZARD MITIGATION

This subcommittee, which meets every 6 months, is comprised of NSF officials, engineers from major universities, and representatives from private industry. The function of this group is the same as other NSF advisory committees--to discuss and assess program progress, provide guidance on future directions, and assist in resolving management problems.

SOUTHERN CALIFORNIA EARTHQUAKE PREPAREDNESS
PROJECT POLICY ADVISORY BOARD

The California Seismic Safety Commission established the Policy Advisory Board to oversee the Southern California Project's activities. The Board is composed of representatives of public and private agencies in the Los Angeles area. The California State Geologist, as well as representatives from other State offices, FEMA, and USGS are also on the Board.

CALIFORNIA GOVERNOR'S EMERGENCY TASK
FORCE ON EARTHQUAKE PREPAREDNESS

According to the former task force director, the task force was intended to be a temporary organization to supplement the efforts of the State Office of Emergency Services by drawing on private sector expertise and resources to plan for a large-scale earthquake. In 1981, its first year, approximately 400 volunteers participated in the task force.

In 1982, the task force consisted of a Steering Committee, including a small Executive Committee, and 31 individual committees. State planners served on both individual advisory committees and the State Planning Committee as a way of linking volunteer efforts with the State's emergency planning process. FEMA representatives participated in the Steering Committee and State Planning Committee meetings. Representatives of other Federal agencies were assigned to various specialized committees but attended only plenary task force or other special meetings. The task force was administered by the task force director with administrative staff support from the State's Office of Emergency Services.

For fiscal years 1982-83, the task force will consist of a smaller steering committee, fewer individual committees, the State Planning Committee, and a new Policy Review Advisory Committee. In addition, a new director has been appointed, and administrative support will be provided by the California Seismic Safety Commission.

INTERAGENCY DISCUSSION GROUP
ON DISASTER MITIGATION

This group promoted by NSF meets monthly. Federal agencies involved in NEHRP attend and listen to a guest speaker. The group is not formally approved but still acts as a dissemination device.

U.S. NATIONAL COMMITTEE ON GROUND MOTION

During our field work this committee was being formed. FEMA, NSF, and USGS will be among the members. About 40 percent of the membership will be comprised of State and local representatives.

EXAMPLES OF WORKSHOPS, CONFERENCES, AND SEMINARSON EARTHQUAKE-RELATED ISSUES WHOLLY ORPARTIALLY SPONSORED BY FEDERAL AGENCIESMEETINGS HELD DURING
FISCAL YEARS 1977 THROUGH 1982International Earthquake Microzonation
Conference (held in 1978 and 1982)

This conference was called to bring together a group of persons from diverse backgrounds/disciplines to (1) summarize the state of the art and knowledge concerning the techniques used around the world for zoning regions for earthquake effects, (2) promote discussions of recently developed theories and concepts, (3) identify future research needs, and (4) publish comprehensive proceedings of the conference.

Seminar on Computer Applications
in Earthquake Engineering (1982)

The objective of this seminar was to disseminate information about new computer applications developed from recent research in earthquake engineering. The methodology and computer software in current use, as well as future developments, were described by the lecturers.

Workshop on Preparing for and
Responding to a Damaging Earthquake
in the Eastern United States (1981)

This workshop brought together 70 individuals representing local, State, and Federal Government; business and industry; and the research community. The workshop provided the participants, many of whom had never met before, a working environment to discuss the earthquake threat in the East and propose solutions for facing it. The goal was to develop and to devise draft 5-year action plans--one each for the central, southeastern, and northeastern United States--to improve the state of earthquake preparedness. Each plan could serve as a guide for public officials, the design professions, and the research community to use in developing future programs to reduce losses from earthquakes and to develop a seismic safety policy in their respective communities.

Workshop on Continuing Actions to
Reduce Losses from Earthquakes in
the Mississippi Valley (1982)

This workshop brought together about 70 representatives from Federal, State, and local governments; academia; and the private sector. Representatives from FEMA headquarters and field offices attended. Discussions covered efforts for preparedness, response, recovery, and mitigation from probable damaging earthquakes along the New Madrid fault zone and other geologically active areas in the region.

U.S. National Workshop on Strong-Motion
Earthquake Instrumentation (1981)

The workshop was organized by a Steering Committee appointed by the Earthquake Engineering Research Institute and the Universities Council for Earthquake Engineering Research. The objectives of the workshops were (1) to review the existing strong-motion instrumentation program in the United States, (2) to develop a unified strategy for the deployment of strong-motion instruments both in the free-field and in buildings, and (3) to formulate a plan for coordinating existing strong-motion programs, the ongoing installation and operation of instruments, and the management of strong-motion data. Experts in earthquake engineering and seismology were invited from all over the Nation to participate in the workshop. In addition, experts were invited from a number of foreign countries.

Annual NBS Federal Workshop Series
on Building Science and Technology

This series was initiated in response to a request from the Office of Management and Budget to promote interagency communication and coordination in the field of building technology. It is sponsored by NBS' Center for Building Technology and is intended for Federal agencies. The workshops focus on current issues in Federal building programs and provide a forum for identifying problems as well as means for translating new knowledge into improved building practices. While discussing a wide range of issues, several sessions have dealt specifically with earthquake-resistant construction.

1982 FEMA/NSF/USGS Summer Institute
on Multiprotection Design

This is a 4-week course for architectural and engineering faculty scheduled at FEMA's Emergency Management Institute in Emmitsburg, Maryland. Seven principal courses are offered, including a 1-week course in earthquake protective designs.

Earthquake Engineering Research
Institute Regional Seminars on
Earthquake Fundamentals (1982)

These seminars were designed for practicing engineers, geoscientists, and Government officials who wish to enhance their ability to evaluate and resolve earthquake problems. The seminars capsulized the important areas of recent progress and the procedures for utilizing earthquake technology. The seminars were held at Salt Lake City, Utah, and Raleigh, North Carolina. Sponsors included engineering associations, universities, and private industry.

MEETINGS PLANNED FOR FISCAL YEAR 1983

Workshop on Site Amplification of
Ground Motion and its Consideration
in Earthquake-Resistant Design

Jointly sponsored by USGS and the Nuclear Regulatory Commission, this workshop will convene about 30 people in the Washington, D.C., area to discuss the technical aspects of the subject in a 3-day meeting.

Conference on the Charleston Earthquake

Jointly sponsored by USGS and the Nuclear Regulatory Commission, this conference will convene about 50 to 60 people in the Charleston, South Carolina, area for a 3-day meeting to discuss the state of knowledge on the Charleston earthquake and its effect on earthquake-resistant design of power plants.

Workshop on Continuing Actions to
Reduce Earthquake Losses in the
Northeastern United States

Jointly sponsored by USGS and FEMA, this workshop is part of a continuing series to reduce earthquake losses in the eastern United States. About 60 to 70 people will participate in the 3-day meeting scheduled for the Boston area.

Workshop on Estimation
of Earthquake Losses

Jointly sponsored by USGS and FEMA, this 3-day meeting of about 30 people in the New Orleans area will discuss the state of the art in estimating earthquake losses.

ADVANTAGES AND DISADVANTAGES
OF LEAD AGENCY ALTERNATIVES

FEDERAL EMERGENCY MANAGEMENT AGENCY

Program participants with whom we spoke considered FEMA the appropriate choice as lead agency for NEHRP for the following reasons:

- FEMA's approach to earthquake planning is more generalized than the other Federal agencies involved in the program, which tend to be more specialized.
- FEMA will have primary responsibility for Federal disaster assistance and response in the event of a Presidential declaration following a major earthquake.
- While Federal agencies are often accused of an "ivory tower" perspective, FEMA has the most exposure to the general public, both on a daily and disaster-related basis.
- FEMA is the only agency involved in NEHRP that has a coordination/management role in its existing charter. The other agencies focus on scientific research.

Others who felt FEMA was not the best choice offered the following criticisms:

- FEMA is not well equipped to handle the job, having neither the authority, the expertise, the credibility, nor the resources to deal with a program heavily oriented toward research.
- FEMA tends to stress emergency management, responding to a single event without an overall perspective or long-range plan.
- There is no clear management team designated at the national level; this lack of definition is reflected at the regional level. None of the national staff assigned to the NEHRP is dedicated solely to the program. Consequently, responsibility for the program cannot be pinpointed to any one group or individual.

U.S. GEOLOGICAL SURVEY

USGS was recommended for the lead because it has the scientific expertise and, of the four primary agencies in the

program, contributes the most resources. According to the Deputy Director of OMB's Management Improvement Group, USGS would also be able to take an assertive lead role if it could attain the backing of the current Secretary of the Interior. Those who questioned USGS as the lead agency noted that, while having the technical expertise, it may not have the management skills needed to direct a complex multiagency program. Also, as a competitor for research dollars with NBS and NSF, USGS' judgments could be open to constant attack on conflict-of-interest grounds. USGS may be inclined to overemphasize prediction research, its primary responsibility. Furthermore, USGS lacks FEMA's experience in disaster preparedness planning and dealing with State and local governments.

OFFICE OF SCIENCE AND TECHNOLOGY POLICY

Several convincing arguments were made for designating OSTP as the lead agency. First, OSTP is in the Executive Office of the President, where it can exert its influence and position on program agencies to move the program forward. Second, OSTP has had extensive experience coordinating other multiagency scientific programs. Third, it has on occasion served as the lead agency. For a short period after passage of the 1977 act, but before FEMA was operational, OSTP served as the lead agency on an interim basis. Also, OSTP is currently chairing the Earthquake Hazards Reduction Working Group, which is one of the 12 working groups supporting the Emergency Mobilization Preparedness Board established by the President on December 17, 1981. The Board's mission is to prepare the Nation to respond rapidly and effectively to meet national needs in the event of major peacetime and wartime emergencies. Fourth, OSTP does not have operational responsibilities, and thus it can take an objective view of program requirements and performance. And fifth, since OMB is also in the Executive Office of the President, OSTP is in a good position to coordinate NEHRP budget issues with OMB.

Unfortunately, OSTP's small size and broad responsibilities raise doubts that it could permanently serve as lead agency. OSTP is authorized 12 permanent positions, but by using detailees the actual staff usually doubles. This is still small in relation to the responsibilities of the Office, which include providing advice on all Federal research in such diverse areas as weapons systems, health research, and space-related research. Consequently, OSTP tries to pick and choose the areas where it takes an interest.

NATIONAL SCIENCE FOUNDATION
WASHINGTON, D C 20550

nsf

March 16, 1983

OFFICE OF THE
DIRECTOR

Honorable Charles A. Bowsher
Comptroller General of the United
States
General Accounting Office
Washington, D.C. 20548

Dear Mr. Bowsher:

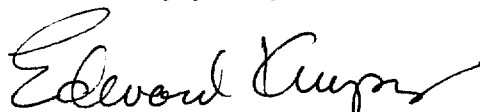
Thank you for the opportunity to review the draft report, "National Earthquake Hazards Reduction Program Needs Stronger Leadership and Improved Management." I would like to supply only two comments.

First, there is a factual error on page three of the main report. To correct this, I suggest that, in line 11, first paragraph, after the word "sponsor" the phrase "fundamental studies on earthquake processes and" be added. This addition reflects the fact that responsibilities in the National Science Foundation are both in our Division of Earth Sciences, dealing with fundamental questions in seismology, and in the Division of Civil and Environmental Engineering, dealing with questions of earthquake engineering and related topics of socioeconomic implications of earthquakes.

Second, while the report focuses on the role of FEMA as lead agency and the need to strengthen FEMA leadership of this program, I believe that there are significant advantages to be gained from the collaborative mode of priority setting and decision making rather than from concentration of budgeting, priority setting, and management within a single agency. The addition of a policy-level interagency committee to coordinate the earthquake hazards reduction program has provided additional strength to overall program management, including FEMA's leadership. In the research area, I believe that NSF and USGS can best manage the program by continuing the present practice of planning, budgeting, and managing the program within each agency, based on the overall priorities established by FEMA and the interagency policy committee.

I would be glad to respond to any further questions you or the Congress might have on this matter.

Sincerely yours,



Edward A. Knapp
Director

**UNITED STATES DEPARTMENT OF COMMERCE
National Bureau of Standards**

Washington, D.C. 20234

OFFICE OF THE DIRECTOR

MAR 9 1983

Mr. J. Dexter Peach
Director, U S. General Accounting Office
Washington, DC 20548

Dear Mr. Peach:

We have reviewed the draft of the GAO report entitled, "National Earthquake Hazards Reduction Program Needs Stronger Leadership and Improved Management." As stated in Chapter 1 the report was primarily concerned with the Federal Emergency Management Agency's role in planning and coordinating the National Earthquake Hazards Reduction Program. The objective specifically did not include an evaluation of the research and mitigation activities of the four participating agencies (Federal Emergency Management Agency, National Bureau of Standards, National Science Foundation, and the U.S. Geological Survey). Consequently, the recommendations of the report are directed to the Federal Emergency Management Agency (FEMA). Our comments are intended to clarify certain aspects of the report and do not take issue with the recommendations since that is considered more appropriate for the Director of the Federal Emergency Management Agency.

Chapter 2 contains two recommendations for FEMA to more aggressively carry out its lead agency responsibilities. The second of the two recommendations is for FEMA to take actions to "conduct a thorough review of the program, to help determine program strategy and priorities, and to help develop guidelines for a management system of planning, budgeting, and evaluation." We do not take issue with this recommendation since all of these are good management practices. However, portions of this recommendation are apparently based upon the GAO review of the Interagency Committee on Seismic Safety in Construction (ICSSC). The report states on page 16 that an evaluation of the purpose and objectives of the ICSSC is needed. The report then goes on to cite three developments which question the value of the ICSSC. All of these points relate primarily to Federal activities in the preparation of seismic design standards. Paraphrasing they are:

1. The draft standard developed by the ICSSC in January 1981 has yet to be tested.
2. Federal agencies have separately developed earthquake design standards.
3. There is a separate effort funded by FEMA to develop guidelines for the private sector which is further along than the ICSSC effort, although the ICSSC was intended to set the example for the private sector.

[GAO NOTE: Page references have been changed to agree with the final report.]

Page 2

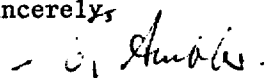
It should be pointed out that prior to the Earthquake Hazards Reduction Act the Federal agencies already had the separate earthquake resistant design standards noted in item 2. Indeed it was the separate design documents that led to the establishment of the objective for the ICSSC to develop a single standard applicable to all Federal agencies. This goal was achieved in January 1981 with the draft standard that was ready for evaluation. We believe the ICSSC effort has contributed toward the development of uniform standards for earthquake resistant buildings which are consistent with the private sector national standards to be used for state and local governments' building codes.

- o the 1981 draft incorporates key aspects of the provisions being considered by the Building Seismic Safety Council (BSSC) several years before the BSSC will be prepared to recommend their provisions for national standards and codes (anticipated 1985).
- o the Federal agencies now have a uniform standard available for trial use to meet current needs for earthquake resistant design.
- o the ICSSC activities are closely linked to the BSSC with ICSSC represented on the BSSC Board and all technical committees to contribute to effective completion of the BSSC work.
- o when BSSC recommendations are ready the Federal agencies will be familiar with them in detail and should be able to recommend them for Federal agencies' use as the successor to the current draft ICSSC standard.

The remaining recommendations to the Director of FEMA concern assistance to state and local governments and to an operational earthquake prediction system. Both of these are outside the scope of the NBS mission and, therefore, we have no direct comment on these recommendations.

We appreciate the opportunity to review the draft of this GAO report.

Sincerely,


Ernest Ambler
Director



United States Department of the Interior

OFFICE OF THE SECRETARY
WASHINGTON, D.C. 20240

MAR 23 1983

Mr. J. Dexter Peach
Director, Resources, Community,
and Economic Development Division
U.S. General Accounting Office
Washington, D.C. 20548

Dear Mr. Peach:

This letter is in response to your February 28 letter transmitting for our review and comment your draft report entitled "National Earthquake Hazards Reduction Program Needs Stronger Leadership and Improved Management." I feel the draft report raises major issues concerning current Federal efforts with regard to earthquake hazards. Our comments will be limited to those elements of the report which relate directly to the responsibilities of the Department of the Interior and particularly to the U.S. Geological Survey.

Our first comment concerns the recommendations on page 22 of the draft report which read as follows:

"We recommend that the Director of FEMA use the existing authority under the act to put in place an interagency mechanism to develop and implement a National Earthquake Hazards Reduction Program as required by law."

"We also recommend that the Director of FEMA request the Director of the Office of Science and Technology Policy to establish a task force under the Federal Coordinating Council for Science, Engineering, and Technology to conduct a thorough review of the program, to help determine program strategy and priorities, and to help develop guidelines for a management system of planning, budgeting, and evaluation."

Comments:

We recommend that the management of the National Earthquake Hazards Reduction Program (NEHRP) remain with the Federal Emergency Management Agency. We do not believe that yet another ad hoc group is required to manage the program. An Interagency Coordinating Committee already exists to coordinate activities among the several federal agencies that participate in the NEHRP. This group, which is chaired by FEMA, is responsible for preparing annual reports to Congress, 5-year activity plans, etc.

Our second comment concerns the recommendation on page 43 of the draft report which reads as follows:

[GAO NOTE: Page references have been changed to agree with the final report.]

2.

"We recommend that the Director of FEMA, in cooperation with officials from USGS and other Federal agencies, determine the level of priority that should be assigned to achieving the technological progress necessary to make a prediction system feasible. This determination should weigh the costs and uncertainties of a prediction system against the potential benefits of reducing loss of life and injuries as well as reducing property damage and disruption. If it is decided that development of an operational system is vital to our Nation's disaster preparedness, then FEMA and the Geological Survey through the National Earthquake Program should seek to arrange adequate funding for its development."

Comments:

The paragraph in the middle of page 41 implies that the Geological Survey is proceeding or planning to implement "a fully operational prototype prediction system." That is not the case. In fact, the Geological Survey has advised that it is premature to make the great expenditures that would be required to implement a prototype operational earthquake prediction system. Currently, scientists do not have confidence in their ability to predict earthquakes on a routine basis. A simple, highly reliable and universal formula for short-term prediction of earthquakes has not been found.

We believe that the Geological Survey's approach to earthquake prediction research is reasonable. Instruments are deployed for research purposes and analytical techniques developed in that research are incorporated into analysis and warning procedures. Those instruments and techniques that are proven unreliable or irrelevant to the effort to develop a reliable capability to predict earthquakes are dropped in favor of more useful activities. We believe this course will provide the research that will allow for interpretation of the data to be made with accuracy and understanding.

Critical issues that must be addressed before an operational prototype prediction system can be considered seriously include at least the following, the first two of which already have been studied by the U.S. Geological Survey but merit further consideration:

- (1) How much of the potential benefits that could be realized if a reliable capability to predict future earthquakes were developed could be achieved now by actions that could be taken by adoption and enforcement of land use restrictions and building codes by State and local officials using existing knowledge about the potential for major earthquakes in their jurisdictions.
- (2) How precise would a prediction have to be (timing, magnitude, and location) before public and private decisions would be made which would result in actions that would measurably reduce deaths, injuries, and losses of property if the earthquake occurred as predicted.
- (3) What are the probabilities of being able to achieve and demonstrate the capability to predict future major earthquakes with the precision necessary to cause decisionmakers to be ready to act on the basis of such predictions.

3.

- (4) What level of annual budget resources would need to be committed and over what period of time in order to test present theories to determine whether or not they could be the basis for development of such a reliable capability to predict future major earthquakes.
- (5) What sources of funding beyond those of the Federal Government ought to be committed to such research if it were pursued.
- (6) What costs and benefits, including long-term changes in the economies of major regions, could and potentially would result from actions taken on the basis of a predictive capability if one could be developed that met the specifications necessary for decisionmakers to act on it.
- (7) Who would bear the liabilities for costs resulting from actions taken based on such a "reliable" predictive capability if a predicted major earthquake did not occur.

Addressing these issues in itself would require a significant period of time and could involve substantial costs. Other groups which would be included in addressing these issues are the Office of the Secretary, Department of the Interior, and the Office of Management and Budget.

Our third comment is on the discussion in Appendix VII concerning advantages and disadvantages of lead agency alternatives. We would like to comment on potentially designating the U.S. Geological Survey as the lead agency for the NEHRP.

Comment:

We concur with the conclusion in the draft report that the coordinating responsibility for the NEHRP should remain with FEMA. We are satisfied with the coordination provided by FEMA, and do not see any need to change the existing administrative structure.

We also have three comments on portions of the text of the draft report and they are as follows:

1. Page 9, last paragraph, the statement:

"In our opinion, a preferable budget process would be to establish the total funding level for the entire program (e.g., NEHRP) with the assistance of the Office of Management and Budget, and then have the affected agencies meet to consider and agree upon an allocation of those funds, consistent with program priorities, to the various program objectives and elements."

Comment:

We do not believe that it would be appropriate to relinquish the budget process to FEMA. We think that the several agencies that receive NEHRP funds are best able to identify and establish budget priorities for their individual programs.

4.

2. On page 17, the statements:

"The NEHRP has received criticism from Congress and some program participants that few of the findings of Federally funded research end up being applied to mitigate earthquake hazards. They believe greater efforts are needed to ensure that research is directed to the needs of those who can implement the findings. . . ." Neither NBS, NSF, USGS . . . "nor FEMA have studied this issue from an overall program standpoint to determine the extent of the problem, if any."

Comments:

We agree this is an area that should be reviewed and the results should be made available to the Congress and the public. There clearly has been an effort to make available the research findings but the question of how much of the findings are being applied to mitigate hazards deserves further evaluation. Examples of efforts already made include those by the Geological Survey to disseminate earthquake research discoveries to State and local governments, as well as to the general public. The Geological Survey, in cooperation with FEMA, the National Science Foundation, and a number of other Federal agencies, has sponsored regional earthquake conferences that have been designed specifically to transfer research results to State and local officials responsible for emergency planning, and land-use and development. Research scientists of the Geological Survey participate in Federal and State committees in seismic design and construction, consult with Federal and State government authorities on the siting of critical facilities in earthquake-prone areas, and encourage and support earthquake research in State and private universities.

In 1976 the Director of the Geological Survey was delegated responsibilities of the Disaster Relief Act of 1974 (Public Law 93-288; 88 Stat. 143) to issue ". . . disaster warnings for an earthquake, volcanic eruption, landslide, mudslide, or other geological catastrophe." The Director is responsible for ". . . technical assistance to State and local governments to insure that timely and effective disaster warning is provided . . ." The Geological Survey has issued a number of such warnings, working closely with state and local elected officials and emergency preparedness personnel, in such situations as the Mammoth Lakes and Coso regions of California.

Within the Office of Earthquakes, Volcanoes, and Engineering of the Geological Survey, there is a Deputy Chief for Research Applications whose role is to ensure the applications of research results.

3. On page 40, Table 3, second line. Available funding for earthquake prediction research has been about \$15.6 million in both fiscal year 1982 and fiscal year 1983 instead of \$15.2 million in 1982 and \$15.1 million in 1983 as indicated in the draft.

5.

Thank you very much for the opportunity to review and comment on this draft report.

Sincerely,

A handwritten signature in cursive script that reads "Dan Miller".

Daniel N. Miller, Jr.
Assistant Secretary for
Energy and Minerals